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Madison, Wisconsin Energy Recovery Project

Brown, Vence and Associates
San Francisco, CA

Prepared for

California State Solid Waste Management Board
Sacramento

Jun 81

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MADISON, WISCONSIN

ENERGY RECOVERY PROJECT

TECHNICAL BULLETIN

June, 1981

Prepared for:

STATE SOLID WASTE MANAGEMENT BOARD
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This technical bulletin is one of a series of reports presenting information gathered in visits to resource recovery facilities around the United States. This study effort has been sponsored by the California State Solid Waste Management Board (CSSWMB). As a number of California resource recovery facilities approach the implementation stage, the CSSWMB has recognized the need to learn from existing projects. In late 1980, five sites were chosen and visited by staff members from Brown, Vence and Associates, consultants to the CSSWMB. These sites included both small and large scale facilities, a number of differing technologies, and projects in varying stages of implementation or operation. The subject of this technical bulletin is the Madison, Wisconsin, RDF-supplemental fuel project.

KEYWORDS: *Solid waste management, *Madison(Wisconsin), *Refuse derived fuels.

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PREFACE

This technical bulletin is one of a series of reports presenting information gathered in visits to resource recovery facilities around the United States. This study effort has been sponsored by the California State Solid Waste Management Board (CSSWMB). As a number of California resource recovery facilities approach the implementation stage, the CSSWMB has recognized the need to learn from existing projects. In late 1980, five sites were chosen and visited by staff members from Brown, Vence and Associates, consultants to the CSSWMB. These sites included both small and large scale facilities, a number of differing technologies, and projects in varying stages of implementation or operation. The five sites were:

- Auburn, Maine
- Duluth, Minnesota
- Madison, Wisconsin
- Saugus, Massachusetts
- Akron, Ohio

The subject of this technical bulletin is the Madison, Wisconsin, RDF-supplemental fuel project.

ACKNOWLEDGEMENTS

We wish to express out gratitude to the following individuals, whose assistance in providing information and reviewing drafts of this report contributed substantially to its final form and content: Mr. Armand Polansky, Chief, Resource Recovery Division, and Mr. Neal Johnson, Economist, State Solid Waste Management Board; Mr. Peter Kmet, Wisconsin Department of Natural Resources (Solid Waste Management Section); Mr. J.R. Stieve, Plant Engineering Manager, Oscar Mayer and Company; Mr. Donald J. Helfrect, President, and Mr. Kent M. Barlow, Manager of Electric Production, Madison Gas and Electric Company; Mr. Gary L. Boley, Director of Engineering and Operations, Wisconsin Solid Waste Recycling Authority; Mr. Robert J. Vetter, Engineering Division, City of Madison; and Mr. M.L. Smith, consultant to the City, M.L. Smith Environmental.

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INTRODUCTION

Since 1979, the City of Madison, Wisconsin, and Madison Gas and Electric (MGE) have operated a joint waste-to-energy project in which a refuse-derived fuel (RDF) produced at the City's Olin Avenue refuse processing plant is burned at MGE's Blount Street Generating Station. From a wasteshed that includes Madison and two smaller communities, the Olin Avenue RDF plant is currently processing 250 tons per day (TPD) of municipal solid waste. The plant operates five days per week. The City transports RDF in transfer trailers to a receiving facility at the Blount Station, where the utility burns RDF in combination with pulverized coal at an average of 15% RDF, 85% coal. The Blount Station provides peak load electrical power to the area power grid.

The Energy Recovery Project is Madison's latest answer to an old problem: lack of long-term municipal landfill capacity. The midwestern city (for location, see Figure i-1) has a history both of strong public support for recycling and of innovative responses to waste management problems. In the late 1960's Madison developed a refuse shredding facility, and operated it successfully for a decade, until it was dismantled to provide a site for the new RDF plant. The waste-to-energy project is a logical second generation evolution of the initial shredding facility. The community's strong support for resource recovery persuaded the City's Common Council to approve development of the project, despite projections that its cost would be markedly greater than traditional landfilling.

Many features of the project reflect Madison's long experience and commitment to waste processing. The City assumed direct responsibility for financing both the RDF plant ($2.84 million, 1978) and the Blount Station receiving facility ($1.06 million, 1978). Staff from the City's Department of Public Works performed process design and equipment selection tasks and, in addition, served as construction managers. Personnel from the original shredding facility contributed markedly to the conversion of the site to RDF production, and participated in a City-sponsored training program that has been a key factor in the successful operation of the new facility. MGE, the local utility, has taken a cordial interest in assisting the City's refuse disposal operations. The utility burns midwestern coal, and thus rapidly-escalating oil prices did not pressure MGE into participation in the project. MGE financed the $580,000 (1978) cost of modifying two of its boilers to fire RDF. The City is exploring new markets for its RDF product, in hopes of increasing the amount of raw wastes that it can process into RDF and then sell. Currently, all RDF produced beyond what MGE can use is landfilled. In conjunction with the University of Wisconsin, the City has embarked upon a test burning program at Oscar Mayer and Company's food processing plant in Madison.

The City does not anticipate profit from the project at any time during its lifetime. The major source of revenue for the project is sale of RDF to MGE; this price is based on the average cost per million BTU's of coal delivered to the Blount Station in the previous quarter, and currently stands at approximately $18 per ton of RDF. The City also charges a $7.50 per ton tipping fee for refuse delivered by the two small communities that use the facility. The principal expenses for the City are operating and maintenance costs, debt service, and a service charge from MGE. The financial bottom line for Madison's waste-to-energy project is that for the last three quarters of 1980 its net disposal cost ranged from $21 to $23 per ton of waste processed.

Important facts about the Madison project are presented in Table i-1.

Figure I-1

STATE OF WISCONSIN - CITY OF MADISON

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Table i-1

FACT SUMMARY
REFUSE-DERIVED FUEL PRODUCTION/COMBUSTION PROJECT
MADISON, WISCONSIN

Population served: 170,000

Operations began: March, 1979

Principals:

City of Madison - owner/operator, facility design and construction management, principal source of refuse

Madison Gas and Electric Company - local utility burning Madison's RDF

M.L. Smith Environmental - technical consultant

Madison Magnetic Operations - rebuilt the ferrous removal system

Madison Solid Waste Fuel Company - developer of the combustibles separator unit

Wisconsin Department of Natural Resources - principal regulatory agency

Oscar Mayer and Company - potential new customer for RDF

Volume: 250 TPD refuse, five days per week, six and one-half hours per day (RDF production).

Technology: Three-stage system

1) Production of RDF with ferrous recovery, use of a flail-type primary shredder, combustibles separation unit, secondary vertical shaft shredder, and air classifier.
2) RDF receiving facility - storage and individually controllable feed lines to boilers.
3) Combustion - cofiring at an average 15% replacement rate with pulverized coal, drop grates added to ensure complete RDF combustion.

Product: RDF at 19 TPH (1980 annual average), average heat content 7,500 BTU/lb (dry weight).

Costs: Plant capital costs: $4.48 million (RDF plant - $2,840,000; RDF receiving facility - $1,060,000; boiler modifications - $580,000).

Revenues:

- RDF purchased by MGE at approximately $18 per ton.
- $7.50 per ton tipping fee from other communities.
- 10% of net profits from the sale of recovered ferrous.
- Reimbursement for operating and maintenance expenses on leased equipment (combustibles separation unit).

Procurement: Competitive bidding with no negotiations, modified architect/engineering approach.

CHAPTER 1

PROJECT ORIGIN

IDENTIFICATION OF NEED

In the late 1960's, responding to the long-term need to minimize landfill requirements and to public support for recycling, the City of Madison developed a refuse shredding facility. This facility was located on the old Olin Avenue landfill site; shredded refuse was landfilled at that site and at the City's Sycamore and Green Tree landfills. Development of the shredding plant was supported by a Federal Environmental Protection Agency grant. The plant began operation in 1968. Ferrous metals were the only recovered resource, although the City accepted (and still accepts) bundled newsprint as part of its municipal refuse collection service. This plant operated successfully for ten years, until it was dismantled to provde a site for the RDF production facility.

The primary factor motivating development of Madison's Energy Recovery Project was the City's lack of long-term municipal landfill capacity. The impending closures of both the Sycamore landfill (1977) and the Green Tree landfill (1980) would force the City to depend completely on the County landfill. The Dane County government, itself encountering difficulties in landfill siting, was not enthusiastic about accepting all of Madison's refuse.

During the late 1960's and early 1970's, informal discussions occurred between the Department of Public Works and MGE regarding combustion of shredded refuse in MGE's boilers. Motivated by the lack of landfill capacity and by the City's refuse shredding experience, these discussions provided the basis for exploring RDF production.

CHRONOLOGY

In 1974, the City and MGE jointly contracted with Horner & Shifrin, Consulting Engineers from St. Louis, Missouri, to prepare a feasibility study of RDF combustion in MGE's Blount Station boilers. The Horner & Shifrin study concluded that production and combustion of RDF was both technically feasible and environmentally sound. In February of 1976, the Department of Public Works presented the City with a special report comparing solid waste disposal alternatives with the RDF project. From these studies, the City concluded that the cost per ton of waste for the RDF system would be consistently higher than for traditional landfill disposal, throughout the life of a ten-year agreement with MGE. Backed by significant community support for resource recovery and recycling, the City's Common Council passed a resolution in March of 1976 authorizing the Director of Public Works to negotiate an agreement with MGE and to begin development of the RDF project. Construction of the RDF production plant began in April 1978; processing began in January, 1979. A detailed chronology is presented in Table 1-1.

KEY PARTICIPANTS

City of Madison, Department of Public Works

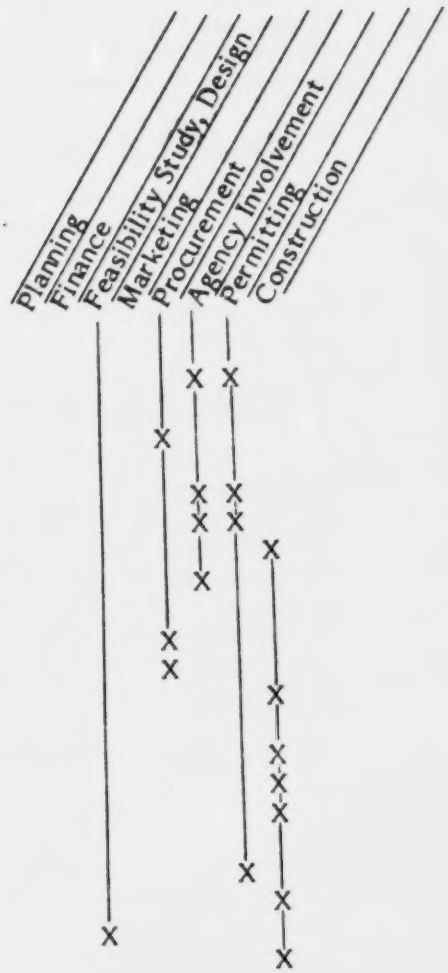
With responsibility for all collection and disposal activities for the City, the Department was the primary project proponent. The City's original refuse shredding facility had provided the Department with extensive experience in refuse processing. The original equipment consisted of a 15 TPD Gondard horizontal shaft shredder, appropriate conveyor systems, Continental Can Company's ferrous removal system, and stationary compactors. The first shredder was later supplemented by a 10 TPD Heil vertical shaft shredder.

Table 1-1

MADISON ENERGY RECOVERY PROJECT CHRONOLOGY

Event	Date	Planning	Finance	Feasibility Study, Design	Marketing	Procurement	Agency Involvement	Permitting	Construction
Horizontal shaft shredder installed - Olin Ave.	1967								X
Vertical shaft shredder installed - Olin Ave.	1969								X
Continental Can agrees to install ferrous metal removal system	December 13, 1971				X				
Magnetic separation system installed; plant modified for full-scale production	1972								X
MGE & the City agree to study feasibility of cofiring RDF & coal	March 12, 1974	X	X						
"Appraisal of Solid Waste as Supplementary Fuel in Power Plant Boilers" submitted to the City by Horner & Shifrin	October 1974		X						
Department of Public Works authorized to discuss waste utilization with MGE	March 25, 1975	X							
"City of Madison - Solid Waste Disposal Alternatives vs. MGE Recovery" by the Department of Public Works	February 19, 1976	X	X						
Director of Public Works authorized to negotiate agreement with MGE	March 23, 1976	X							
Contract negotiation with MGE	April-May 1976				X				
DPW authorized to submit letter of intent to State Department of Natural Resources	May 25, 1976	X				X	X		
Dane County Solid Waste Management Plan adopted	June 17, 1976	X							
Agreement to use RDF signed by City & MGE	January 11, 1977				X				
Preliminary plans submitted for Olin Ave. submitted to DNR	May 10, 1977					X	X		
DNR grants approval of new air source at Olin Ave.	July 22, 1977					X	X		
Preliminary plans for RDF receiving station submitted to DNR	August 8, 1977					X	X		
City resolution of interest in Oscar-Meyer test program	August 9, 1977	X							

Event	Date
Notice of intent - new source at RDF receiving station submitted to DNR	November 1, 1977
Madison Solid Waste Fuel agrees to supply separation system	November 30, 1977
DNR approval of RDF receiving station	January 24, 1978
DNR approval of Olin Ave. plant	April 24, 1978
Olin Ave. construction begins	April 1978
Training program for plant personnel	April-Dec. 1978
EPA grant application for Oscar-Meyer test program submitted	June 29, 1978
EPA approves grant application	October 1978
Olin Ave. construction complete	January 1979
Processing of first ton - primary shredder	January 27, 1979
RDF - first ton produced	March 1979
RDF - first ton cofired	June 1979
DNR approval of Oscar-Meyer test facility	October 18, 1979
RDF formally accepted by MGE	April 1, 1980
Testing begins at Oscar-Meyer	November 1980
Secondary shredder accepted	



With the experience of a decade in refuse processing, the City felt confident of its ability to develop a second-generation refuse processing facility. Few municipalities seeking to develop a similar project possess such a background. The Department assumed an unusual role in project development in that City staff performed principal engineering design and specification preparation tasks in addition to serving as construction managers. Former Public Works Director Edwin J. Duszynski played a key role in developing the Energy Recovery Project.

Madison Gas & Electric Company

MGE generates electricity principally to fill the demands of the urban Madison area and provides supplementary power to the area power grid. MGE, burning mid-western coal, was not under particular pressure from rapidly increasing oil prices to participate in the project. A major factor in project development was MGE's interest in aiding municipal refuse disposal operations, as personified by Mr. Fred Mackie, former MGE President.

M. L. Smith Environmental

The City contracted with M. L. Smith of Oak Brook, Illinois, to provide technical assistance and direction to City project staff. Mr. Smith was responsible for recommending the technological process concept, providing technical review of City-selected process components, preparing technical specifications for equipment, and providing technical review and advisory services, as necessary. Mr. Smith had previously been employed with the Continental Can Company (CCC), developers of Madison's original ferrous recovery system. When CCC pulled out of the recycling business, M.L. Smith left the company to form his own consulting service. The City of Madison was among Mr. Smith's first clients.

Madison Magnetic Operations, Inc. (MMO)

This company was formed when CCC left the recycling field. Mr. Robert Grisemer, formerly with CCC, received the rights to develop the Madison ferrous system, assumed the CCC contract, and made improvements to the system. When the RDF production plant was being developed, MMO agreed to remove the old system and to rebuild it, at MMO's expense and risk. MMO retains ownership of the system and shares revenue from ferrous sales with the City.

Madison Solid Waste Fuel Co. (MSWF)

This company was also formed by Robert Grisemer specifically to meet the City's need for a combustibles separation unit. MSWF and Raytheon were the two bidders for this contract. MSWF's separation system had never been tested before installation; Grisemer assumed all the risk, agreeing to remove the system if it failed to meet specifications. It has been highly successful, and is generally believed to incorporate a rotary screen device similar to a trommel. The specifics of the machinery are proprietary information under MSWF's contract with the City. The City leases the equipment.

Oscar Mayer and Company

Oscar Mayer and Company operates a large food processing plant in Madison. The company is currently considering use of Madison RDF as a supplemental fuel with coal in one of its industrial boilers. A test firing program is currently under way.

FEDERAL, STATE AND LOCAL REGULATIONS AND PERMITS

The only local permits issued were building permits.

The State of Wisconsin's Department of Natural Resources was the primary permitting agency for both the solid waste and air quality aspects of the project. The Solid Waste Management Section, Division of Environmental Standards permitted both facilities as solid waste processing/handling facilities. The permit for the Olin Avenue RDF production plant was simply a modification of the permit for the original shredding operation. The Department's Air Quality Section reviewed project plans and required no permits. Review and approval of new sources of air emissions (dust at the RDF production plant and at the receiving facility) were performed by the Air Quality Section. No formal permits were issued; however, the air quality division examined calculations for dust emissions and, with these emissions below cut-off limits set by the National Ambient Air Quality Standards, approved the use of a baghouse at both the RDF production plant and the RDF receiving facility. The Air Quality Section had previously approved the installation of electrostatic precipitators on boiler Nos. 8 and 9 for coal combustion at the Blount Station; calculations performed by the Air Quality Section did not indicate that firing RDF would require any further control measures. As originally installed, the electrostatic precipitators were sized to handle low sulfur coal and were regarded as adequate to handle additional particulate emissions.

No permits have been required for residue (combustion ash) disposal, as the current disposal site is properly licensed. At this time, the DNR does not consider RDF ash to be a hazardous waste.

The only environmental impact assessment prepared on the Energy Recovery Project was written by the DNR Solid Waste Management Section (SWMS) in its review of project plans during the permitting process. No significant impacts were identified and the DNR/SWMS concluded that a formal EIR or EIS would not be necessary. The DNR/SWMS has maintained close communication with the City of Madison, with frequent site inspections. The DNR Air Quality Section did not prepare or require environmental impact documents.

CHAPTER 2

PROJECT DESCRIPTION

LOCATION AND WASTESHED

Plant Location

The Olin Avenue Refuse Processing Plant is located south of the Madison city center and immediately west of Lake Monona. The RDF plant is situated on an old landfill, now closed and reclaimed as City parkland. The processing plant and paved areas occupy approximately four acres. The plant is bordered to the north by park recreational facilities; to the south by Dane County Coliseum and Fairgrounds; to the east by park extending to the shore of Lake Monona; to the west by park. A single-family residential area northeast of the plant and a candy factory to the southeast are the only residential or commercial areas near the plant. Figure 2-1 shows the site of the RDF plant and the RDF receiving facility at Blount Station.

Wasteshed

The majority of waste received at the RDF plant originates in the City of Madison. It is collected from single-family residences, duplexes and some commercial areas by the City's Sanitation Division and delivered to the plant in packer trucks. The Madison School District also delivers of a small quantity of waste that is collected by District vehicles. The communities of Monona and Maple Bluff also deposit refuse at the plant; collection is by municipal vehicles. Figure 2-2 shows the location of these communities; Table 2-1 identifies MSW quantities deposited by each community. The public is restricted from the facility and utilize available landfills of their choice. More communities are expected to utilize the plant subsequent to closure of the Dane County Verona landfill in 1984. Depending on the eventual location of a new County landfill, increased haul costs and disposal fees may prompt additional communities to use the Olin Avenue plant. The City will only accept such increased tonnages, however, if a market can be located for the resulting additional RDF product.

Table 2-1

TONNAGE DISPOSAL BY COMMUNITY
(1980)

Agency	Tons Per Year*
City of Madison, Sanitation Division	42,695
City of Madison, School District	5
City of Monona	3,400
Village of Maple Bluff	1,900
TOTAL	48,000

* City of Madison estimates

Figure 2-1

LOCATION OF OLIN AVENUE RDF PLANT & BLOUNT STREET GENERATING STATION

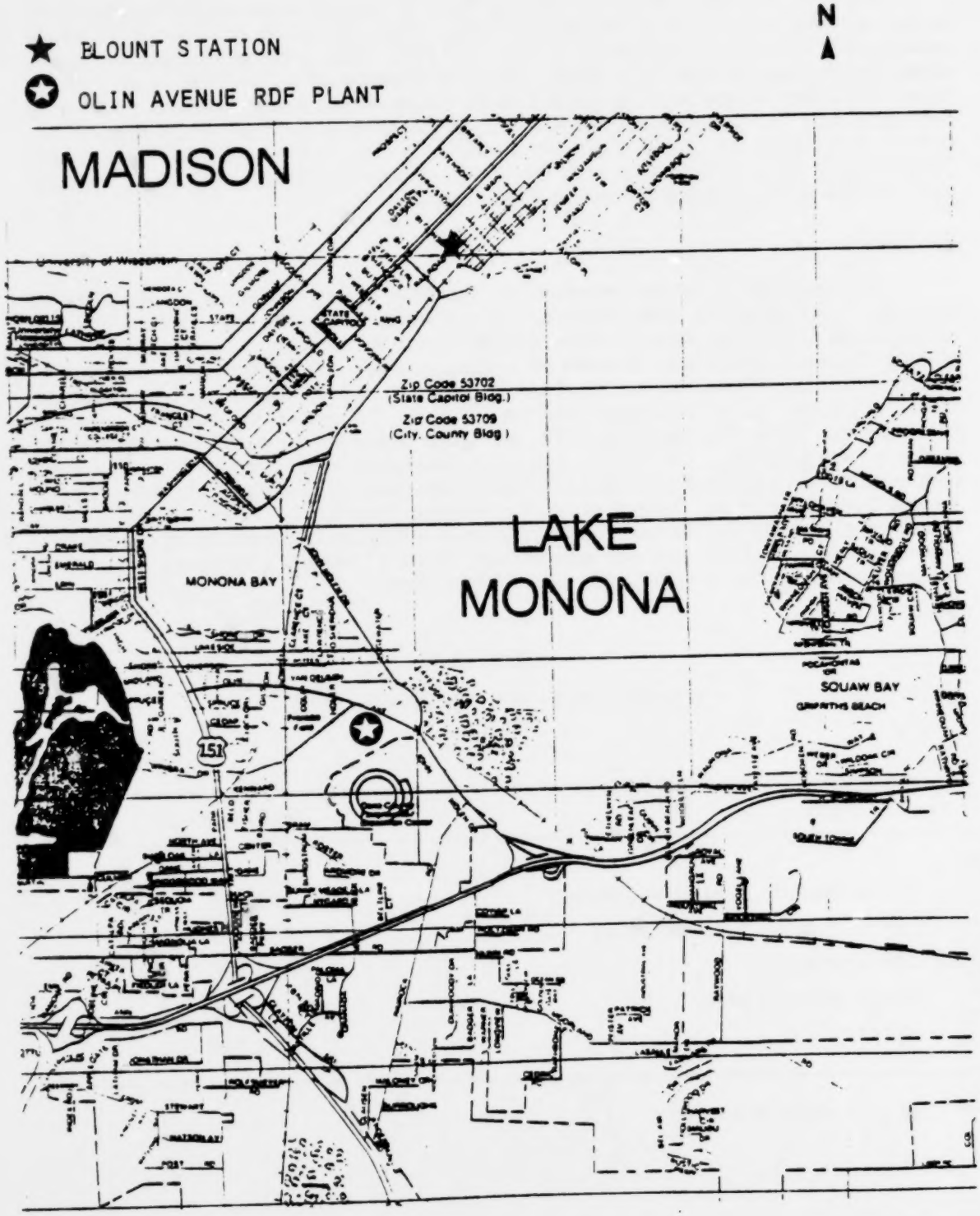


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Figure 2-2

LOCATION OF COMMUNITIES DEPOSITING REFUSE AT OLIN AVENUE

MATERIALS FLOW DESCRIPTION

The Madison Energy Recovery Project can be regarded as a three-stage system: 1) RDF production, 2) RDF receiving and feed to boilers, and 3) combustion in boilers Nos. 8 and 9 at the Blount Station. In the resource recovery industry it is classified as an "RDF/supplemental fuel" system.

RDF Production

The Olin Avenue facility can operate in three different modes: 1) as a simple transfer station, 2) as a transfer station employing shredding and ferrous recovery for size reduction, and 3) as a plant producing RDF. Figure 2-3 is a flow diagram of RDF production; Figure 2-4 shows the layout of the Olin Avenue plant. At the RDF plant, refuse is deposited onto a concrete tipping floor. A front-end loader with a four-in-one bucket removes unprocessible materials from the refuse; the loader operator does some manual sorting. This refuse is then deposited onto a conveyor feeding a primary shredder. The front-end loader may also stockpile refuse in a portion of the receiving area; the operator is responsible for a consistent feed rate. If necessary, raw refuse on the tipping floor can be pushed directly into a stationary compactor loading a long-haul trailer. The allows the plant to function as a simple transfer station, in the event that the entire processing line is inoperable for a period exceeding the storage capacity of the facility.

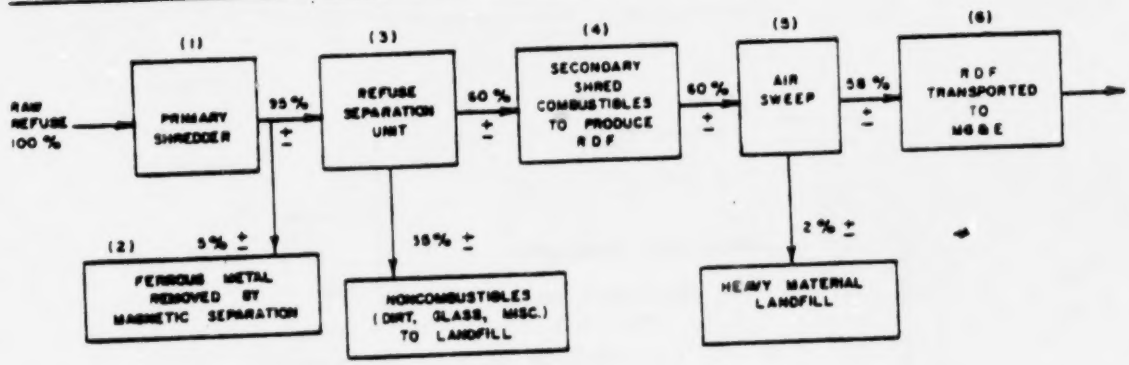
From the primary shredder (horizontal feed, flail-type), the waste is conveyed to a ferrous metal removal system. This system includes a single stage drum magnetic separator. Recovered ferrous is densified by a double-roll crusher and conveyed through an air cleanup process, then discharged to a transfer trailer for transport to market. The trailer is connected to a winch system which, when automatically activated, pulls the trailer gradually forward to insure uniform filling. This system also eliminates the need for excessive time spent coupling and uncoupling trailers. Nonmagnetics fall onto a reversing conveyor that can feed either the combustibles separation unit or another stationary compactor for transport to and disposal at a distant landfill.

The combustibles separation unit is believed to incorporate a rotary screen (proprietary), is leased by the City from Madison Solid Waste Fuel Co. The desirable combustibles are separated from the noncombustibles and then are conveyed to a secondary shredder. Noncombustibles are conveyed to the stationary compactor for loading to trailers and ultimate disposal at the Verona landfill. The combustibles, after secondary shredding, are discharged into a vertical shaft air classifier. After air classification, the lights (RDF) are removed from the air stream in a cyclone. Heavies from the air classifier are conveyed to trailers for transport to the Verona landfill. RDF is discharged from the cyclone onto a reversing conveyor, which can load to either of two stationary compactors that pack transfer trailers.

Air is pulled through the cyclone and into the low-pressure side of an air handling fan. Discharge from the fan is split to supply: 1) the secondary shredder (creating an air sweep effect, to assure movement of RDF through the shredder), 2) the base of the air classifier (bypassing the shredder), and 3) a baghouse (in which a fraction of the total air flow is cleaned prior to release). Makeup air is introduced via several dust collection hoods located at conveyor transfer points and other dust sources around the processing plant.

Figure 2-3

RDF PROCESS FLOW DIAGRAM

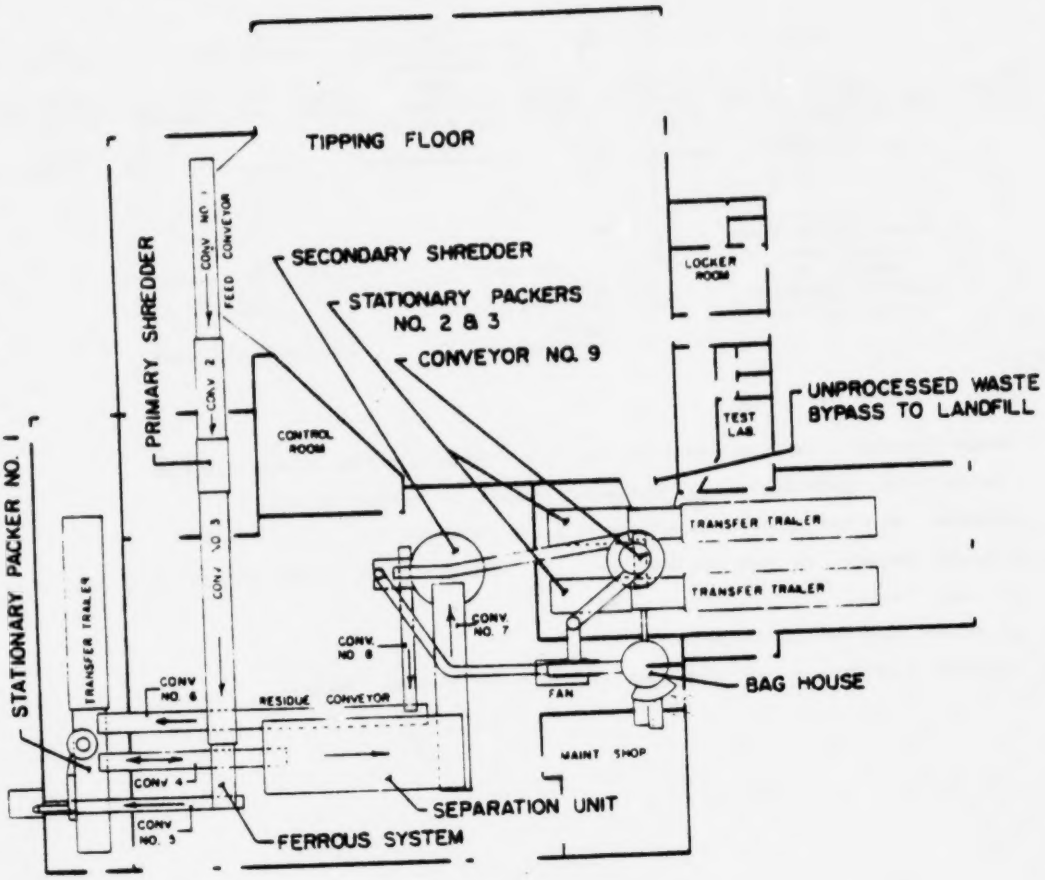


1. PRIMARY SHREDDER — 50 TONS PER HOUR (45 t/h) 60 % LESS THAN 8 INCH (20.4 CM).
2. FERROUS METAL SEPARATION — ELECTROMAGNETIC REMOVAL OF FERROUS METAL.
3. SEPARATION UNIT — ASH CONTENT LESS THAN 15 % (AS RECEIVED).
4. SECONDARY SHREDDER — 38 TONS PER HOUR (34.5 t/h) 98% LESS THAN 2 INCH (5.08 CM) 90 % LESS THAN 3/4 INCH (1.91 CM)
5. AIR SWEEP — FINAL AIR CLASSIFICATION.
6. TRANSPORT EQUIPMENT — 65 & 75 CUBIC YARD (50 & 57.5 m^3) TRANSFER TRAILERS.

SOURCE: Barlow, et al., ASME paper (see p. 60)

Figure 2-4

RDF PLANT LAYOUT



SOURCE: Barlow, et al., ASME paper (see p. 60)

RDF Receiving Facility

The City transports RDF in 75 yd^3 transfer trailers to the RDF receiving facility at the Blount Station. The receiving facility is a 100' x 60' pre-engineered metal building with two rooms (see Figure 2-5). The actual receiving room is sized to store, if necessary, two transfer trailers; this room is maintained by the City. The room containing the actual storage bins and RDF feed system is maintained by MGE; the City is allowed to occupy the building site and owns the entire building. RDF is push loaded into the bins by the trailer bulkheads.

Each of the two storage bins has the capacity to store about 1 1/2 trailer loads (approximately 110 yd^3) and is unloaded using two twin H-type augers. The augers are of variable speed and feed individual conveyor systems. Each conveyer system feeds a fuel injection nozzle on one side of a boiler. The conveyors feed rotary air locks which discharge RDF to pneumatic conveyor lines carrying RDF to the injection nozzles. Because of the independent design of the four unloader/feed systems, boiler operators retain a high degree of control over individual feed rates. Controls for the RDF feed system are located in the boiler control room. Figure 2-6 is a cross section of the RDF feed system.

Combustion

RDF is co-combusted with pulverized coal in MGE's boiler Nos. 8 and 9. These are 50 MW Babcock & Wilcox waterwall boilers with a design capacity of 425,000 lbs of steam per hour at 1,250 psig and 950°F. Consultations with the various manufacturers of the five coal-fired Blount Station boilers determined that the Babcock & Wilcox boiler Nos. 8 and 9 were the ones most suitable for burning RDF. RDF is injected into each boiler by means of two air-cooled injection nozzles which were installed between the bottom and second level coal ports. Installation of the nozzles occurred at that level to avoid combustion of RDF in the convection passes of the boilers. Figure 2-7 presents a boiler cross-section.

RDF is burned in semi suspension with firing completed on drop grates. The drop grates were installed to ensure complete refuse combustion while avoiding fires in the ash pits. Also installed were two fans per boiler to supply underfire and overfire air to the grates, in order to promote combustion. RDF and pulverized coal are fired simultaneously. Ash is dumped and then removed via a dry vacuum system for silo storage prior to landfilling.

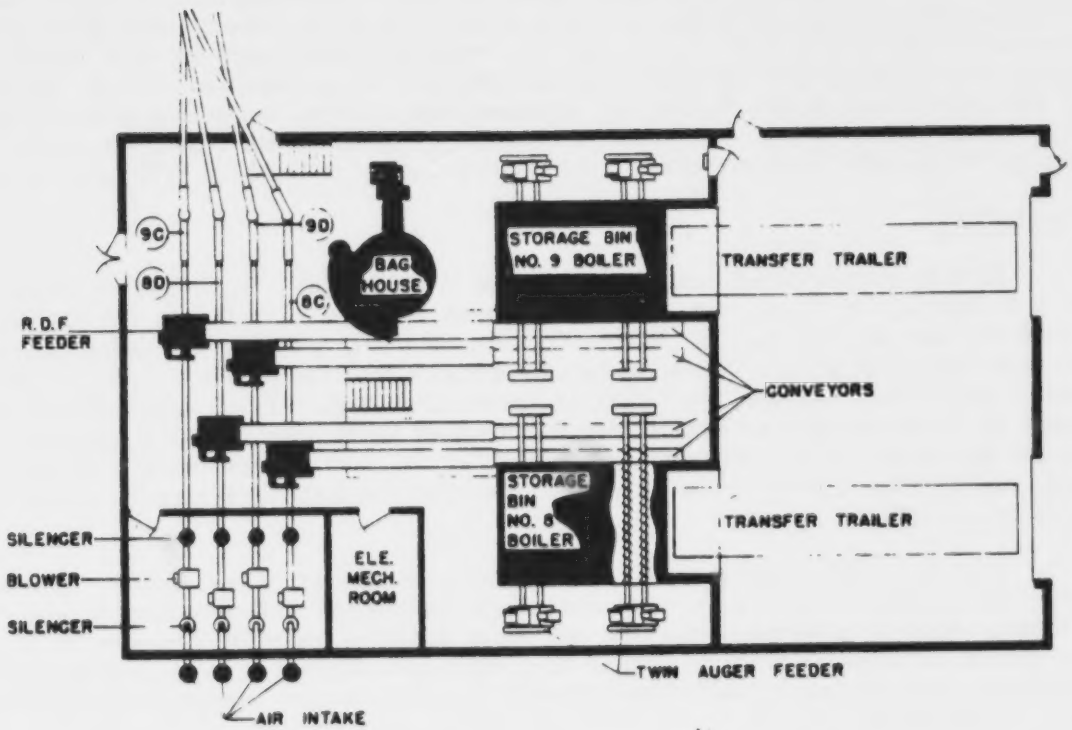
Boiler controls were not modified to burn RDF, as plant personnel are experienced in burning natural gas and coal simultaneously; RDF and coal are fired in a similar manner. Permissive interlocks were inserted into the boiler controls, however, to ensure that minimal conditions are met before firing RDF. RDF cannot be burned unless the following conditions obtain:

- boiler load at 60% or above
- both coal pulverizers in operation
- coal pulverizer feeders in the automatic mode
- underfire/overfire air fans are on.

Normal burning hours for RDF are from 7:00 AM to 10:00 PM, Monday through Friday. The normal operating hours of the RDF production plant are 7:00 AM TO 9:50 PM, Monday through Friday, with RDF produced during the morning and early afternoon.

Figure 2-5

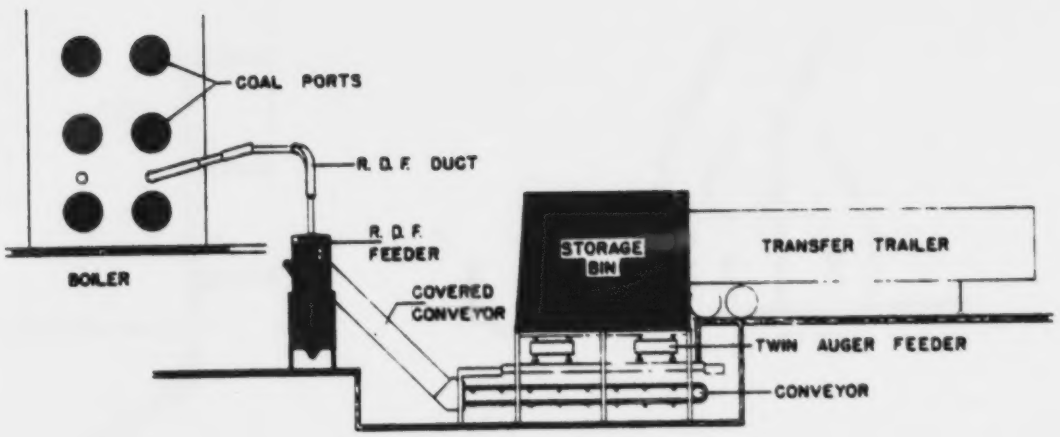
RDF RECEIVING FACILITY LAYOUT



SOURCE: Barlow, et al., ASME paper (see p. 60)

Figure 2-6

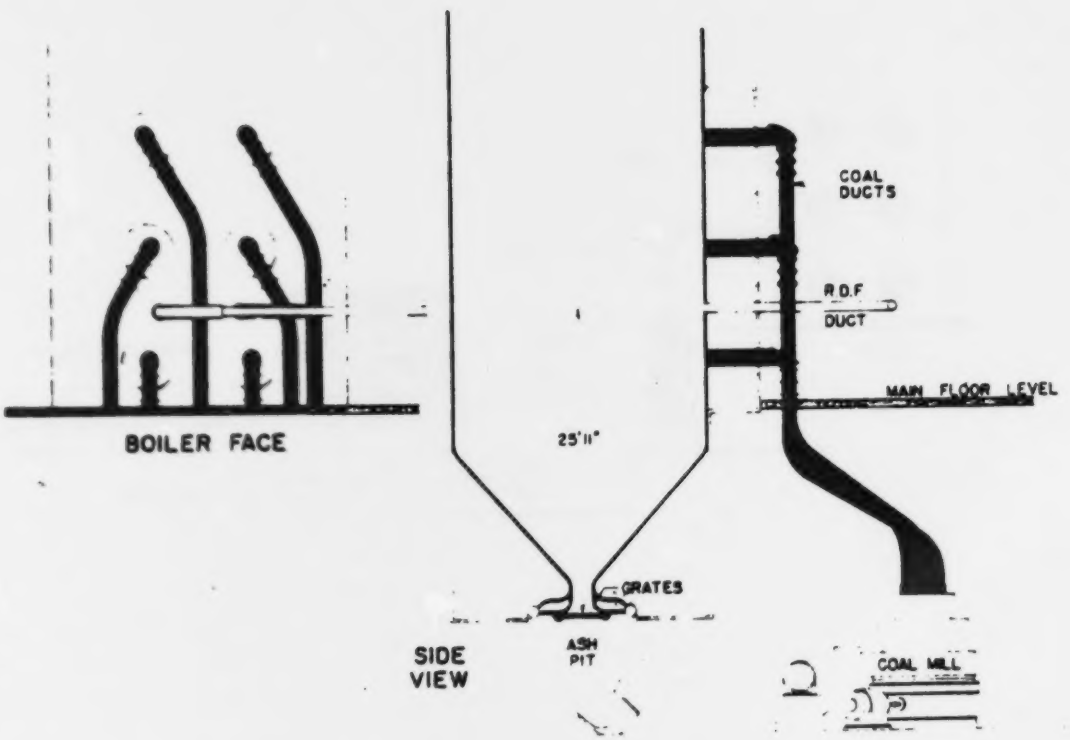
RDF FEED SYSTEM (CROSS SECTION)



SOURCE: Barlow, et al., ASME paper (see p. 60)

Figure 2-7

MGE BOILER (CROSS SECTION)



SOURCE: Barlow, et al., ASME paper (see p. 60)

FACILITY DESIGN/ACTUAL OPERATING RATES

Processing Capacity

The RDF plant was designed to process 50 TPH of refuse through one processing line. The facility was not designed to accomodate a second process line. Operations at the facility have verified the processing capacity of 50 TPH. Average amounts of refuse processed range from 140 TPD during the winter months to 400 TPD during the spring and summer.

Feed Material and Product Specifications

Prior to construction of the RDF production plant, the City did not conduct waste composition studies. For the previous decade, the City had, however, been shredding MSW from its wasteshed at the Olin Avenue Reduction Plant. This provided the City with working experience concerning what kinds of wastes would be acceptable at its RDF facility. The RDF plant accepts only residential waste and limited commercial waste. It does not accept hazardous wastes, explosives, demolition, industrial, most commercial wastes, or other potentially harmful or nonprocessible wastes. Commercial wastes accepted at the plant are limited to those of selected neighborhood commercial areas.

Based on two short-term test burns in MGE's boiler Nos. 8 and 9, the City and MGE agreed to the following RDF product specifications:

- Maximum ash content - 15% by weight*
- Particle size - 95% less than $1\frac{1}{2}$ inches
- Moisture content - approximately 30% by weight*
- Heating value - approximately 5,000 BTU/lb.*

No specification was made in the City contract for the cleanliness of the recovered ferrous product; this is the responsibility of Madison Magnetic Operations, which owns the recovered ferrous and is responsible for all marketing.

Production Rates

The RDF plant can process, on a consistent basis, 35 to 40 TPH of refuse. Average feedstock input is approximately 36 TPH with RDF production averaging 19 TPH, or fifty-five percent (55%). Ferrous recovery averages approximately 6% of input tonnage, or 2 to 3 TPH.

Residue Production

At the time of system design, residue production was estimated at approximately 40-48% of the input material tonnage, including ferrous recovery. Operating experience has demonstrated that direct process residues, exclusive of recovered ferrous, average about 39%. At an average input rate of 36 TPH, residues are produced at a rate of approximately 14 TPH.

* expressed on an "as received" basis

EQUIPMENT PERFORMANCE SPECIFICATIONS

Detailed equipment performance specifications were available only for the equipment in the Olin Avenue RDF production plant. All equipment has performed to specifications and has been accepted by the City.

Primary Shredding System

The primary shredder was designed to have a capacity of 50 TPH on an average daily basis, with a surge capacity to 65 TPH. It should handle MSW with a bulk density of approximately 250 to 300 lbs/yd^3. This "flail-type" shredder was designed to produce an approximate product particle distribution as follows:

Mesh	Percent Passing Range
4"	60%
2"	40%
1"	25%
1/2"	15%

Feed and takeaway conveyors were designed to operate at a sufficient velocity to maintain production rates. Figure 2-8 is a cut-away view of the primary shredder.

Ferrous Metal Recovery System

In the City's intial contract with Continental Can Company for ferrous removal at the original refuse shredding plant, the City specified that the system shall "remove substantially all ferrous metals from the shredded solid waste stream." This contract was assumed by Madison Magnetic Co. (currently known as Madison Magnetic Operations, Inc.) when the RDF production facility was developed. At that time, no new contract equipment performance specifications were written. Specifications for the combustibles separation unit, however, indicate that City officials expect the ferrous system to recover approximately 90% of the total ferrous in the waste stream.

Combustibles Separation Unit

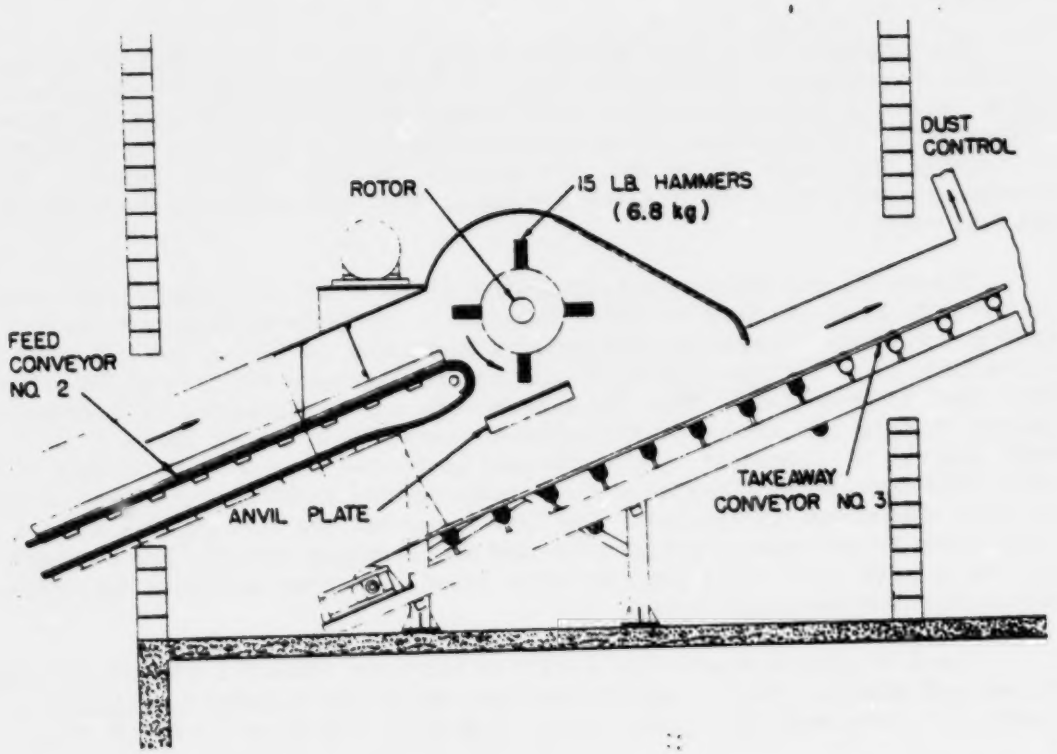
This piece of equipment is expected to process 50 TPH on a daily average basis, with surge capacity to 60 TPH; it is operational for seven hours per each eight hour shift. Feed material can vary from 3 to 12 lb/ft^3 bulk density; input particle size should be as specified for primary shredder output performance with approximately 90% of the ferrous metals removed. Recovery of combustibles is expected to reach a minimum of 60% of input feed material, with a maximum ash content of 15% by weight. Specifications stated only that "it is desirable that essentially all of the glass be removed;" no percentages were identified. Specifications did not specifically require the use of a trommel.

Secondary Shredding System

This system is designed to handle 35 TPH on a daily average basis with a surge capacity to 40 TPH. Feed material is assumed preprocessed as noted in the preceding

Figure 2-8

PRIMARY SHREDDER



SOURCE: Barlow, et al., ASME paper (see p. 60)

specifications; feed is normally to be 60% greater than 4 inches with a top size of approximately 24 inches. Input densities of 3 to 7 lb/ft^3 are expected; approximately 75% of feed should be paper, with an anticipated metal fraction of one to two percent.

Discharged material is to be 95% by weight less than 3/4 inch with a maximum of 1% greater than 2 inches. Feed conveyor is of sufficient speed to maintain production rates. All materials processed in the secondary shredder are discharged through an air sweep and air conveyance system to stationary compactors. The air system is to be capable of accepting up to 40,000 cfm and to include provisions for eliminating dense and oversize items which exceed particle specifications. Specifications indicate only that the air classification system be designed to remove heavy, dense objects and large, oversize materials in excess of the 1% of oversize material (over 2") specified as the product from the secondary shredder. Figure 2-9 illustrates the total secondary shredder and air sweep system.

STAFFING

The original Olin Avenue refuse shredding operation was staffed by eleven plant personnel (9 operators, 1 clerical, 1 manager). These personnel played a significant role in the successful development of the RDF production facility. The staff dismantled the existing equipment and rebuilt three pieces of equipment to be re-used in the RDF plant; the landfill stationary compactor, the primary shredder infeed conveyer, and the reversing conveyor from the magnetic separator. They also assisted in the installation of this equipment.

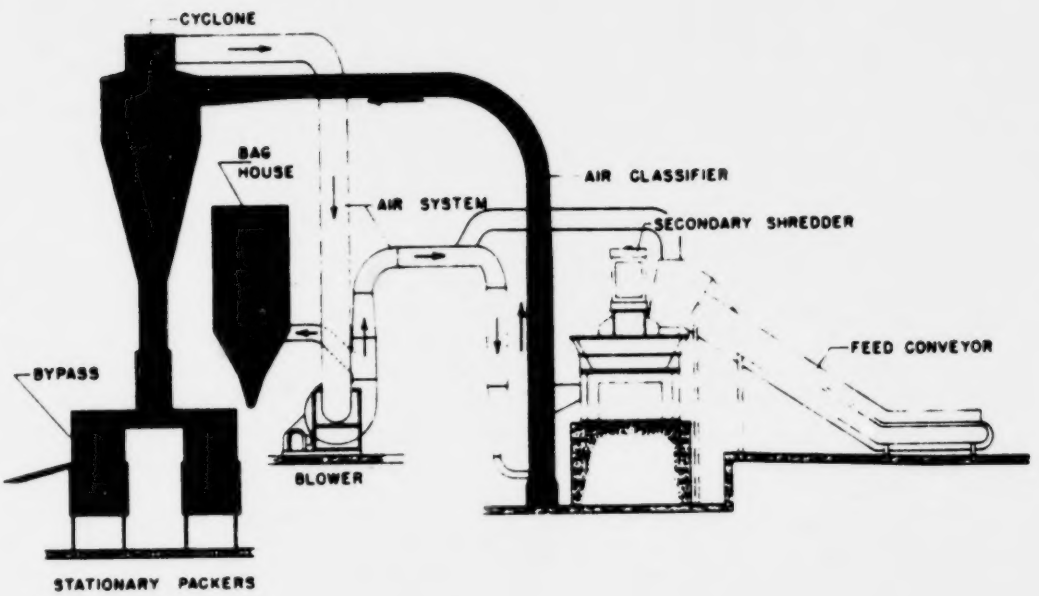
During the construction and installation of major new equipment, plant personnel were sent to a training program which consisted of 120 hours of classroom instruction in welding, electrical systems, air flow systems, hydraulics, conveyors, and tool usage given by the local junior college. Table 2-2 lists required course-work; the training period was from April to December, 1978. The course-work was supplemented by in-house maintenance training and touring of RDF-related operations at MGE's Blount Station. The staff assisted in equipment installation and performed routine maintenance prior to initial MSW processing. They were fully knowledgeable about the processing system by the time shakedown commenced. The City feels that the training was an invaluable contribution to successful plant operation and high employee morale. Three persons have left the original crew; their positions were filled, and three additional personnel have been added since operations began.

The RDF plant currently has a staff of fourteen; Table 2-3 presents job classifications and salaries. Plant operators are members of the National Association of City, County and Government Employees Union, Local #236. The plant is a closed shop.

The plant personnel work two staggered shifts from 7:00 AM to 9:50 PM, although starting times for personnel on the first shift may vary. Four personnel are necessary for the actual plant operation. The fourteen personnel includes staff for driving RDF transport trucks. Maintenance tasks are performed throughout the two shifts, with the majority of maintenance work usually occurring during the evening hours of plant operation.

Figure 2-9

SECONDARY SHREDDER - AIR SWEEP SYSTEM



CHAPTER 3

PROJECT FINANCES AND RISK ALLOCATION

Table 2-2

RDF PLANT OPERATORS' TRAINING PROGRAM

	Course	Subject Matter	Hours of Training
I.	Welding	Electrode composition Metal-types Hard surfacing Build-up welding Out of position welding Acetylene torch Safety	30
II.	Electrical Systems	Basic electrical flow Trouble shooting Use of test equipment Procedure & safety in testing Electric motors Maintenance	30
III.	Air Flow Systems	CFM's-requirements Negative air pressure; make-up air Air scrubbing Air conveying Air cleaning Maintenance	15
IV.	Hydraulics	Working components Oil flow & filtration Pressure settings & testing Maintenance & cooling	15
V.	Conveyor Systems	Types & purpose Repair Adjusters & adjustments Drives	15
VI.	Tool Usage	Metric & standard Air operated Electrical Gauges	15
VII.	Plant Maintenance	Preventive maintenance in-house Types & use of grease & oil Housekeeping Material & parts usage	in-house
VIII.	MGE Plant Tour	In-depth tour to explain flow pattern and maintenance problems; to show cause and effect of product size and cleanliness.	in-house

Table 2-3

JOB CLASSIFICATIONS AND SALARIES

Classification	Personnel	Salary*[a]
Maintenance Worker II*[b]	1	$13,568. annual
Mill Operator I	8	$15,211. "
Mill Operator II	4	$16,912. "
Plant Manager	1	$22,000. "

*a benefits rate of 26% not included in salary figures
*b performs laboratory analysis and clerical duties

METHOD OF FINANCE

The City of Madison assumed direct financing responsibility for the RDF production plant, which it owns and operates, and the RDF receiving facility, owned by the City with MGE maintenance costs passed through to the City. The City financed the costs of these facilities ($3.9 million) through a combination of monies including: money from the City's General Fund, routed through the Department of Public Works; ten-year promissory notes followed by tax-exempt general obligation bonds; and Federal revenue sharing money from the Community Development Block Grant (CDBG) program. Table 3-1 presents the financing breakdown; Table 3-2 details the capital cost of facilities development. These costs include the expenses of dismantling the original refuse milling plant and of all subsequent reconstruction to accommodate the new RDF processing equipment.

The $580,000 cost of modifications to boiler Nos. 8 and 9 at the Blount Station was financed by MGE. This cost is calculated into MGE's service charge to the City, amortized over a five-year period. The $580,000 includes the cost of drop grate installation, boiler tubing, RDF piping, installation of underfire and overfire fans, and start-up expenses.

The City established a special revenue account to receive project revenues and to pay MGE service charges. Figure 3-1 illustrates the flow of project funds, with actual dollar amounts for 1980. These figures differ from the 1980 projections discussed below, because the project did not begin to generate revenue until the second quarter of 1980.

FINANCIAL PERFORMANCE

Revenues

At the time of project development, four sources of revenue were projected: ferrous revenue, RDF payment by MGE, disposal fees, and MMO & MSWF equipment operating and maintenance payments. The oil entitlements program was an unanticipated fifth source of revenue, which was targeted for future research and development work on processing equipment. In August of 1980, entitlements payments were averaging $10.41/ton. The entitlements program ended in January, 1981. Research efforts must now be funded from other revenue sources. The City's Common Council has approved funding of 1981 research and development efforts from internal sources.

RDF Fuel Payments: The major source of project revenues is the fuel payment made by MGE, projected at $1.59 per MMBTU's, or about $18 per ton of delivered RDF. Payments for RDF are calculated "at the same cost per million BTU's as the average cost of delivered coal at the Blount Street Station for the previous quarter." The City must pay MGE a service charge for expenses incurred by burning RDF.

MGE's service charge includes amortization of MGE's capital expense to modify its boilers, O&M charges, preferential loading charges, and a boiler efficiency loss charge. The last two of these charges are described in greater detail below. In addition, MGE may bill the City for any ash disposal costs incurred which are over and above normal expenditures for ash disposal. Such expense would be calculated into the service charge. No charges are made for the City occupying the RDF receiving facility site.

Combustion of RDF has resulted in a rise in boiler stack temperature of 30°F. This in turn has caused a boiler efficiency loss that MGE has estimated to be $2\frac{1}{2}$%. MGE bills the City a dollar amount calculated to cover the cost of this effciency loss.

Table 3-1

FINANCING COST BREAKDOWN

Year	Amount	Source
1977	$1.505 million	Direct appropriation from the General Fund
	.850 million	Promissary notes, 4.06720% interest for 10 years
	.253 million	Transferred from landfill siting account (City General Fund)
1978	$.250 million	Direct appropriation from the General Fund
	.250 million	Promissary notes, 5.18431% interest for 10 years
	.375 million	Community Development Block Grant (Federal revenue sharing funds)
1979	$.100 million	Promissary notes, 5.33609% interest for 10 years
1980	$.025 million	Promissary notes, 6.02461% interest for 10 years
	.010 million	Funded as part of a municipal promissory note.

Table 3-2

CAPITAL COSTS

OLIN AVENUE MADISON RESOURCE RECOVERY CENTER

	General Contractor Sullivan	Electrical Contractor Staff	Plumbing Contractor Osborn	Mechanical Contractor Kilgust	Equipment Universal Welding	Equipment Heil Company	Purchase Orders	Construction Totals	Consultants Smith & Meyer	Warzyn Engineering	Total
Contract Amount	$610,999.00	$113,125.00	$80,260.00	$73,030.00	$151,691.67	$873,177.00	$153,030.33	$2,057,263.00	$ 3,190.72		
Change Order Amount	43,663.98	22,996.00	9,690.37	4,530.00	17,144.38	41,807.00		139,831.73	35,000.00		
Total Amount	$654,662.98	$136,121.00	$89,950.37	$79,560.00	$168,786.05	$914,984.00	$153,030.33	$2,197,094.73	$38,190.72	$103,386.33	$2,338,671.78
									City Engineering		155,081.00
									Site Improvement		72,028.00
									Plant Personnel		108,555.00
									Start Up Cost		168,802.68
									Total Cost		$2,843,138.46

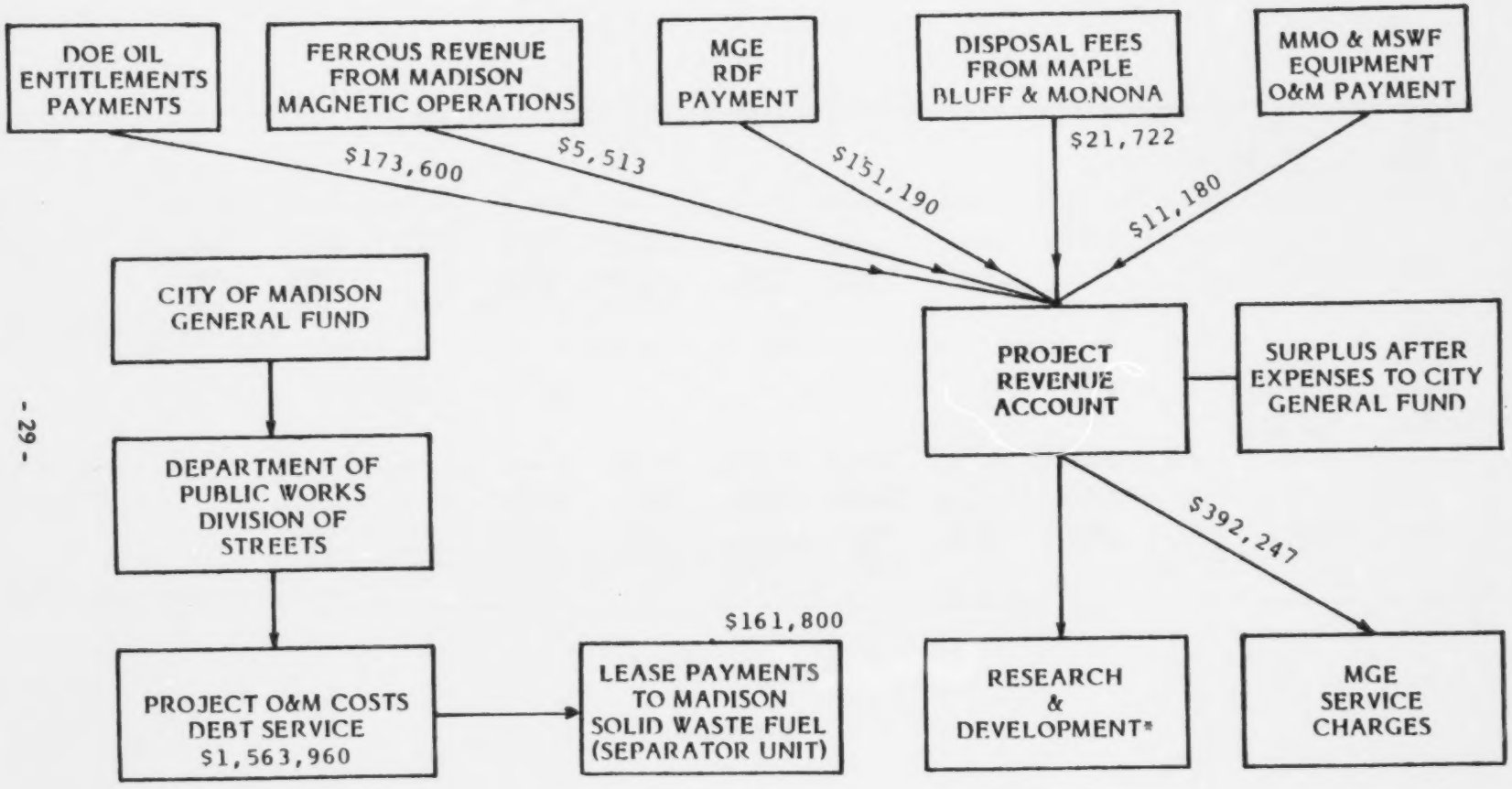
BLOUNT STREET RECEIVING STATION AT MGAE

	General Contractor Daniels	Electric Contractor Nichols	Plumbing Contractor Mechanical	Mechanical Contractor Kilgust	Equipment Installation Daniels	Equipment MAC	Equipment Miller Hoft	Purchase Orders	Construction Totals	Consultants Smith	Warzyn Engineering	Totals
Contract Amount	$194,400.00	$31,721.00	$22,900.00	$15,900.00	$65,400.00	$184,429.22	$281,089.00	$14,112.00	$809,949.22			
Change Order Amount	5,317.00	20,102.67	1,230.00	553.10	6,461.35				33,664.12			
Total Amount	$199,717.00	$51,823.67	$24,130.00	$16,453.10	$71,861.35	$184,429.22	$281,089.00	$14,112.00	$843,613.34	$15,000.00	$63,135.58	$921,748.92
											City Engineering	40,000.00
											Start Up Cost	100,000.00
											Total Cost	$1,061,748.92

Figure 3-1

PROJECT REVENUE FLOW

1980



* DOE oil entitlements were previously targeted for R&D activities and channeled through the revenue account; with the cessation of these payments, R&D activities will be financed by general fund appropriations. No data was available on 1980 R&D expenditures.

MGE supplies peak load electrical power to the area power grid. As the Blount Station is a peaking power plant, in order to load the less efficient boiler Nos. 8 and 9 with RDF, the City agreed to pay a preferential loading charge - a dollar amount calculated to meet the cost of the efficiency loss incurred by using the Blount Street boilers instead of a more efficient generating station. The City has set a ceiling on the preferential load charge it will pay. MGE's total service charge is approximately $7 per ton of combusted RDF. The City's net revenue from MGE (RDF payments minus service charge) is on the order of $10 per ton RDF ($5 per ton of input refuse).

Tipping Fees: Disposal fees are received from the communities of Maple Bluff and Monona; the current tipping fee is $7.50 per ton. The disposal fee equals the City of Madison's cost to transfer and haul the waste to the Verona landfill, 10.5 miles away. This fee represents a savings to Monona and Maple Bluff over their own projected costs of haul to the Verona landfill. All drivers must weigh loads at the facility scale house prior to dumping loads. The communities are billed on a monthly basis. Tip fee revenues may increase as the County landfill and other municipal landfills close or have restricted access due to diminishing capacity. Dane County currently charges $3.75 per ton for disposal; however, capacity will diminish significantly in the future. The County hopes to site another landfill; but it is expected to be distant from many communities and to have a significantly higher disposal fee.

Other Revenues: The City receives 10% of all net profits resulting from the sale of ferrous metal by Madison Magnetic Operations, Inc. Madison Magnetic Operations, Inc. also reimburses the City for operating and maintenance expenses. In addition, Madison Solid Waste Fuel (MSWF) reimburses the City for operating and maintenance expenses incurred in the operation of the combustibles separation unit.

Expenses

The project has five areas of expense: 1) operating and maintenance, 2) debt service, 3) lease payment to MSWF, 4) MGE service charges, and 5) research and development activities. Items four and five were described above.

The principal expense to the City is operating and maintenance costs, projected at $18 per ton (1980) and including both the RDF production plant and the RDF receiving station. The City pays operating and maintenance expenses, including MSWF equipment lease charges, from the General Fund, as part of the Department of Public Works budget.

Debt service is also paid from the General Fund (see Figure 3-1). The City's debt service for both the RDF production plant and the receiving station was projected at $9 per ton (1980).

Total expenses on a per ton basis, excluding the MGE service charge and research and development monies, were projected at about $27 per ton.

Net Cost

With total revenues for 1980 projected at approximately $4 per ton to $6 per ton, the net annual cost to the City is projected at $21 per ton to $23 per ton. Cost pro-

jections for the years 1980, 1985 and 1990 are presented in Table 3-3. The City does not anticipate profit from the project at any time during its useful life.

Continued formation of "clinkers" on the boiler grates (see Modifications, Chapter 4) may necessitate further modifications; such additional capital expense would be borne by the City.

RISK ALLOCATION

The risk allocation in the Madison project was perhaps the key element in successful project development. With the exception of the ferrous removal system and combustibles separation unit, the City assumed all of the project risks, including: waste supply, residual disposal, facility construction, facility operation, debt service, and securing an RDF market. Madison Magnetic Operations assumed the risk for the ferrous removal system, as did Madison Solid Waste Fuel for the combustibles separation unit. MGE assumed no financial risk in the venture; however, the modification of the boilers presented the potential for a maintenance problem. Additional residue from RDF firing was not considered a significant problem.

The City of Madison played an unusual role as the risk-assuming developer of the Energy Recovery Project. The City's willingness to assume practically all major risks removed what could have been significant obstructions to the implementation of the project.

Contracts

Madison-MGE: This contract specifies that either party may suspend operations (RDF production or firing) and requires cooperative resolution of problems. If problems cannot be resolved, the contract may be terminated upon mutual consent. MGE is obligated to pay only for RDF actually combusted; RDF that is accepted but not burned must be removed by the City.

Madison-MSWF: This contract specifies an annual base payment for lease of the combustibles separation unit. In addition, a payment per ton processed is made on a graduated scale. Failure of the unit requires MSWF to remove the equipment and bear all associated costs.

Madison-MMO: This contract specifies that the recovered ferrous product is the property of MMO. The City receives 10% of all net profits resulting from the sale of ferrous product; MMO is solely responsible for marketing. In the case of equipment failure or inadequate performance, MMO is responsible for the removal of the system and for associated costs.

Madison-Monona: This contract is an agreement to supply refuse under the same terms as City-delivered refuse, i.e., only residential and light commercial waste. The City of Madison assumes responsibility for transfer and disposal of refuse should RDF production be suspended or halted altogether.

Madison-Maple Bluff: This contract contains the same conditions as the Madison-Monona agreement.

Table 3-3

MADISON'S ENERGY RECOVERY PROGRAM
COST PROJECTIONS

	1980	1985			1990		
	55,000 Tons/Yr	55,000 Tons/Yr	75,000 Tons/Yr	100,000 Tons/Yr	55,000 Tons/Yr	75,000 Tons/Yr	100,000 Tons/Yr
Recovery Plant Processing and Transportation							
Amortization - City Capital	406,900	406,900	406,900	406,900	0	0	0
Labor (increasing @ 9%/yr)	300,000	443,000	604,300	803,700	576,400	786,200	1,045,6000
Electrical Power (increasing @ 8%/yr)	115,000	161,000	219,600	292,100	225,400	307,500	409,000
Heat (increasing @ 8%/yr)	7,000	9,800	9,800	9,800	13,720	13,720	13,720
Equipment - includes transfer (increasing @10%/yr)	100,000	140,000	190,960	254,000	190,000	259,160	344,700
Phone	1,200	1,400	1,400	1,400	1,600	1,600	1,600
Water & Sewer	400	500	500	500	600	600	600
Supplies (increasing @ 5%/yr)	60,000	72,000	72,000	72,000	87,000	87,000	87,000
MSWF Company	180,000	180,000	195,000	206,250	180,000	195,000	206,250
Miscellaneous	9,000	11,000	11,000	11,000	13,000	13,000	11,000
Disposal of Residues	65,000	75,000	100,000	133,000	90,000	125,000	166,250
	$1,244,500 ($22.62/ton)	$1,500,600 ($27.28/ton)	$1,811,460 ($24.15/ton)	$2,190,650 ($21.91/ton)	$1,377,320 ($25.04/ton)	$1,788,780 ($23.85/ton)	$2,285,720 ($22.85/ton)
Blount Street RDF Receiving Station							
Amortization - City Capital	140,000	140,000	140,000	140,000	0	0	0
MG&E Costs							
Amortization - MG&E Capital	130,000	0	0	0	0	0	0
O&M Charges (increasing @ 10%/yr)	60,000	90,000	122,800	163,300	120,000	163,700	217,700
Taxes	10,300	10,300	10,300	10,300	10,300	10,300	10,300
Miscellaneous (increasing @ 10%/yr)	2,000	3,000	3,000	3,000	4,000	4,000	4,000
	$342,300 ($6.22/ton)	$243,300 ($4.42/ton)	$276,100 ($3.68/ton)	$316,600 ($3.17/ton)	$134,300 ($2.44/ton)	$178,000 ($2.37/ton)	$232,000 ($2.32/ton)
TOTAL ANNUAL COST	$1,586,800 ($28.85/ton)	$1,743,900 ($31.70/ton)	$2,087,560 ($27.83/ton)	$2,507,250 ($25.07/ton)	$1,511,620 ($27.48/ton)	$1,966,780 ($26.22/ton)	$2,517,720 ($25.17/ton)
Revenue							
Refuse-Derived Fuel* (increasing @ 6%/yr)	440,000	572,000	780,000	1,037,400	743,600	1,014,000	1,348,600
Ferrous Metal	0	5,000	6,750	9,000	7,500	10,125	13,500
MSWF Labor Charge (increasing @ 9%/yr)	10,000	14,500	19,720	26,200	21,025	28,600	38,000
	$450,000 ($8.18/ton)	$591,500 ($10.75/ton)	$806,470 ($10.75/ton)	$1,072,600 ($10.75/ton)	$772,125 ($14.04/ton)	$1,052,725 ($14.04/ton)	$1,400,000 ($14.04/ton)
NET ANNUAL COST	$1,136,800 ($20.66/ton)	$1,152,400 ($20.95/ton)	$1,281,090 ($17.08/ton)	$1,434,650 ($14.35/ton)	$739,495 ($13.44/ton)	$914,055 ($12.18/ton)	$1,177,620 ($11.18/ton)

* Assumes 52% recovery as RDF; 80% RDF is fired: 14 MBTU/Ton of RDF; 15% moisture in RDF.

CHAPTER 4

PROJECT EVOLUTION

PLANT RELIABILITY

As discussed in Chapter 2, the RDF production plant can be operated in any of three modes: 1) as a simple transfer station; 2) for shredding, magnetic separation and transfer to a landfill; 3) for RDF production. This flexibility ensures that some means of disposal is always available. In addition, RDF Plant Manager Ken Brunner and MGE Blount Station Manager Kent Barlow coordinate scheduled downtimes; whenever possible, major RDF plant maintenance is scheduled during regular boiler maintenance periods.

The RDF plant has experienced only three major shutdowns. In December of 1979, a fire occurred in the RDF receiving facility at Blount Station. Also, a fire occurred in the RDF production plant's 480V distribution system in April, 1980. In July, 1980, there was a major explosion in the primary shredder. Due to these incidents, plant personnel estimate an overall reliability of approximately 86%; this figure should increase to perhaps 95% if such incidents can be avoided.

MODIFICATIONS

RDF Production Plant

The most significant equipment modification has been adjustment of machinery configurations in the ferrous metal removal system; this could really be considered "fine-tuning" as no equipment was materially changed.

Additional explosion vents are planned for the primary shredder room; lift-off roof panels are now taped in place rather than bolted. These changes are a result of the July, 1980, explosion.

No modifications of equipment or process are currently being planned.

RDF Receiving Facility

The RDF boiler feeding system has experienced several problems. One problem was spillage of RDF when it was augered to the boiler feed conveyor belts; this was corrected by the manufacturer. Dust problems have been mitigated by placement of air intakes along the conveyor belts to the baghouse. Large pieces of RDF have caused jams in the airlocks; this is expected to be corrected by quality control at the RDF production plant. While the augers are of variable speed drive, significant changes in feed rate (20-30%) require a change in auger speed of approximately 50%. This is attributed to the uneven consistency of the RDF; no immediate remedy has been identified.

Blount Station Boilers

In addition to the modifications to the boilers necessary to enable burning of RDF (injection nozzles, drop grates, blower fans), modifications are being sought to alleviate the formation of "clinkers" or ash bridging over the grates. The "clinkers" are crystalline in appearance, with diameters of two to four feet. The formation of clinkers is attributed to the glass content of the RDF and to insufficient underfire air. The Babcock & Wilcox boilers have dry ash pits designed to operate under a negative pressure, making it very difficult to fire RDF with sufficient underfire air. When enough underfire air has been supplied, the ash pit has leaked combustion gasses. This problem has been addressed by the boiler consultant, Combustion Engineering, which was responsible for all boiler modifications. Modifications to boiler No. 8 are planned for May, 1981; they will involve increasing the diameter of the underfire air passage holes. If this change is successful, boiler No. 9 will be modified in the fall of 1981.

The firing of RDF has caused an estimated boiler efficiency loss of about $2\frac{1}{2}\%$. The City pays the cost of additional heat input required due to this efficiency loss.

IMPACT ASSESSMENT AND COMPLIANCE

Air Pollution

The area including the Blount Station generating plant is a secondary nonattainment area for SO_2. The nonattainment classification was made on the basis of ambient air quality modeling. The air quality modeling studies performed by the DNR Air Quality Section have indicated that the Blount Station is a significant source of SO_2 emissions and contributes substantially to the model's prediction of nonattainment. The Air Quality Section has promulgated SO_2 emissions limits for Blount Station; these limits are to take effect November 15, 1981. Emissions of chlorides and particulates while firing RDF are also of concern to the Air Quality Section. A stack emissions testing program is planned for June, 1981; the test program will measure chloride and particulate emissions while burning coal with RDF. SO_2 emissions will be measured at the same time to determine if combusting RDF, a very low sulfur fuel, reduces SO_2 emissions significantly. The testing program should allow a much clearer assessment of air emissions from the Blount Station's RDF/coal-fired boilers.

Ash Disposal

The DNR has performed no studies on the impacts of leachate from refuse ash. MGE is siting a new landfill for Blount Station ash; in conjunction with this new landfill, the DNR expects to ask the City and MGE to study the effects on ash of firing RDF at the Blount Station.

SUCCESSES, FAILURES, REMEDIES

Project Coordination

One of the key factors in the successful development of the Madison Energy Recovery Project was the careful planning and coordination of development efforts. The Madison project greatly benefited from the initiative and continuity of effort of both Ed Duszynski, former Director of Public Works, and Gary Boley, a City engineer and the eventual project manager. Mr. Boley, who has since joined Combustion Engineering, Inc., was instrumental in all aspects of project development, including planning, design, and implementation. Mr. Bob Vetter, a City engineer, was also a member of the project team, serving as the City's on-site construction manager. Mr. Vetter currently is the City's principal engineer assigned to the project.

The Madison project developed slowly, allowing adequate time for consideration of ideas and for review of developing technologies. An important factor in the project's success was the scale of the technological process line, i.e., designed only to fulfill the function and rate of production that was actually necessary. The project was designed to an appropriate scale largely through the City's desire to minimize capital investment while achieving the desired solid waste disposal function. The project was a logical second-generation evolution of the initial refuse shredding facility.

The continuity of personnel was a very important factor, including the continuity of MGE employees. Mr. Fred Mackie, MGE president who originated the project with Mr. Duszynski, was succeeded upon his retirement by Mr. Donald Helfrect, the current MGE president. Mr. Kent Barlow, MGE's Manager of Electrical Production, has been involved with the project since its inception.

Participant Cooperation

The degree of cooperation and communication between the key project participants was also a vital factor in successful implementation. City officials and MGE personnel were able to work closely together to resolve problems and to structure the project to meet realistic expectations.

The City's early efforts to involve the State Department of Natural Resources and its attention to regulatory requirements facilitated project permitting and approvals. On the other side of the coin, Department of Natural Resources' demonstrated a willingness to work with the City throughout the permitting and approval process.

Community Support

The citizens of Madison have long been strong proponents of materials recycling. The public supported the City's initial venture into refuse shredding and, unlike some similar projects elsewhere, was enthusiastic about the Energy Recovery Project. This was a critical factor in the development of the project, allowing the City's Common Council to select a nontraditional and comparatively more expensive waste disposal method.

In this same spirit of community support, the Madison press provided objective and timely coverage of the project's evolution. This, again, has not been the case in other communities seeking to develop similar projects.

Participation of Plant Personnel

The staff of the original Olin Avenue shredding plant was involved in many aspects of on-site development. They assisted in removing old processing equipment, rebuilt certain items, assisted in installation of rebuilt and new equipment, and performed initial maintenance and adjustment of equipment. Their involvement and the benefits of the City's training program have been key factors in successful plant operation, especially in the areas of maintenance and safety. The good morale and low turnover of personnel attest to the desirability of involving staff in facility development, wherever possible.

The RDF plant manager, Mr. Ken Brunner, has supervised operations at Olin Avenue since the later years of the original milling plant. To this position he brought many years of industrial process line experience. Mr. Brunner's personnel and operations management policies are key factors in the efficient operation of the facility.

Explosion Suppression

The RDF production plant was specially designed to withstand explosions in the primary shredder. The shredder was confined in a distinct room with six lift-off roof panels, explosion vents and roll-up doors. The major explosion to date occurred in mid-July, 1980, when a 30" x 6" acetylene cylinder exploded in the primary shredder. The force of that blast blew out all the roof panels, buckled the two doors, and shattered the wire-enforced glass of the control room view window directly above the shredder room. No injuries occurred.

RDF Production Plant Control System

The RDF production plant is centrally controlled by an operator utilizing closed circuit view cameras and windows to the tipping floor, primary conveyor, and primary shredder. Signal lights are used for tipping floor communication and radio contact is maintained with staff on the production floor and with trailers hauling RDF. Effective communication and efficient process line control are two important elements of the plant's successful operation.

Equipment Performance

All equipment in the RDF production facility have met contract performance specifications; the City has officially accepted all equipment items.

FUTURE DEVELOPMENTS

RDF Market Expansion

The RDF production plant is capable of processing 75,000 TPY of refuse; the facility currently processes about 48,000 TPY. At this time, markets do not exist for all the RDF currently produced; the excess is landfilled. It is expected that maximum MGE demand will require only 80-85% of the current RDF production output. In 1980, MGE fired 10,260 tons of RDF; 7,135 tons were landfilled. Although MGE's Bount station has five boilers, not all of them are in regularly scheduled service. Blount Station, as a peaking power plant, regularly fires only boiler Nos. 8 and 9, which currently burn RDF; the remaining three coal-fired boilers are fired only as electrical load demands require. MGE considers combustion of RDF in these boilers as impractical and therefore desires no greater quantities of RDF. In addition, no financial incentives for MGE exist as it pays for RDF on a $/MMBTU basis equal to its cost for coal.

In seeking to utilize fully the current RDF production capacity, the City of Madison approached Oscar Mayer & Company in 1978 about burning RDF as a supplemental fuel with coal. Oscar Mayer was receptive to the idea and, in conjunction with the City of Madison and the University of Wisconsin - Madison Engineering Department, developed a test firing research program.

In June of 1978, the City submitted a grant application to the Environmental Protection Agency (EPA) under the solid waste research grants program. The grant, in the amount of $471,411 for the first phase, was awarded in October, 1978. Total budget for the two-phase program is $688,000; the entire program has been funded. However, due to pending federal budget revisions, funding may not be available for future, similar test programs in other locales. The City has administered the grant and has served as prime contractor for all physical plant modifications. M.L. Smith Environmental was retained as technical consultant.

The test program, conducted by University of Wisconsin personnel, has three objectives: to evaluate industrial boiler performance at various boiler loads and RDF feed rates to determine optimum operating conditions; to evaluate air emissions and performance of the existing particulate control device, a cyclone; and to conduct an economic analysis of utilizing RDF. Tests are being conducted on Oscar Mayer's boiler No. 5, a Wicks four-drum water-tube type with a Detroit roto-grate (spreader stoker), rated to 140,000 lbs. of steam per hour. The boiler is fired using $1\frac{1}{4}$" to 10"-mesh coal.

The test program required construction of an RDF receiving facility and installation of a belt conveyor system and feed chutes to the boiler. RDF is fed by screw feeders and pneumatic distributors. Figure 4-1 illustrates the receiving facility and feeding system. Figure 4-2 illustrates the boiler feed system. Replacement rates were designated as 20%, 50% and determination of maximum replacement rate; boiler loads were designated as 60%, 80% and 100% for testing these RDF replacment rates. The test program is monitoring air emissions, both before and after pollution control, of particulates, SO_2, NO_x, HC, CO, HF, H_2SO_4 and organic acids.

As of March, 1981, the Oscar Mayer test program had conducted nine tests, with the remaining four test firings to be completed by May 1, 1981. RDF has been fired at a maximum replacement rate of fifty percent (50%) at 100,000 lbs/steam per hour. No apparent increases in visible stack emissions have occurred nor has there been a significant increase in particulate emissions. There has been no slagging in the boiler or formation of "clinkers" (ash bridging) experienced to date as a result of co-firing RDF.

Variable BTU value of the RDF has caused some problem in adjusting the coal and RDF feed rates to maintain boiler efficiency; some loss of efficiency has occurred as a result. Modifications to the drive end of the RDF transfer conveyor were necessary. In addition, the RDF feed chutes have been modified to avoid combustion of RDF in the water-jacketed ends of the chutes. The chutes have been shortened by three inches to remove a portion of the water jacket; three inches of boiler refractory were then added. The Oscar Mayer test program fires RDF of the same specifications as produced for MGE boilers. No additional boiler maintenance has been required to date as a result of firing RDF. The RDF receiving facility and conveyer feed system, however, have presented additional maintenance requirements for Oscar Mayer.

Oscar Mayer is considering the continued co-firing of RDF in its boiler subsequent to the test program; the decision is dependent on the final test program results, on the extent to which maintenance requirements are increased, and especially on the BTU value of RDF, i.e., a favorable dollar value for RDF comparable to the dollar per BTU value for traditional fuels. The City hopes that the test program at Oscar Mayer will result in a another contract for delivery of RDF, thus utilizing all current production. Development of further markets or delivery of greater quantities to Oscar Mayer would require additional waste supply. The City will allow an increase of refuse accepted at the RDF plant only if a market exists for the RDF product. No other specific marketing efforts are being pursued at this time.

Future Developments with MGE

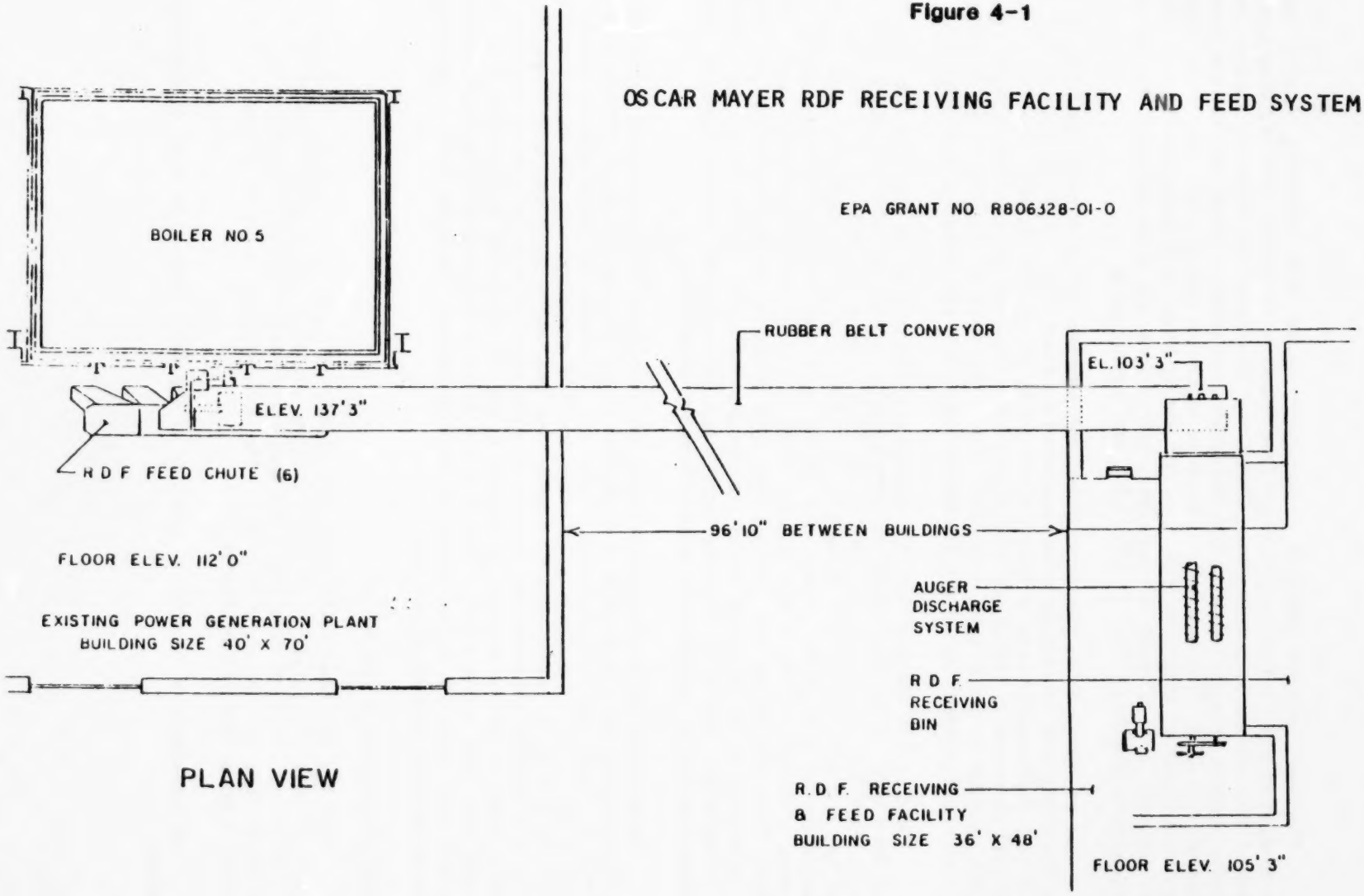
MGE has indicated that the amount of RDF which they will burn in the future is dependent upon resolution of the ash bridging problems experienced in both Blount Station boilers. While no time frame has been set for resolution of the problem, the City and MGE hope to identify a solution. The ash bridging has been discussed in the Modifications section of this chapter.

No expansion of processing capacity at the RDF production plant is currently planned.

Figure 4-1

OSCAR MAYER RDF RECEIVING FACILITY AND FEED SYSTEM

EPA GRANT NO. R806328-01-0



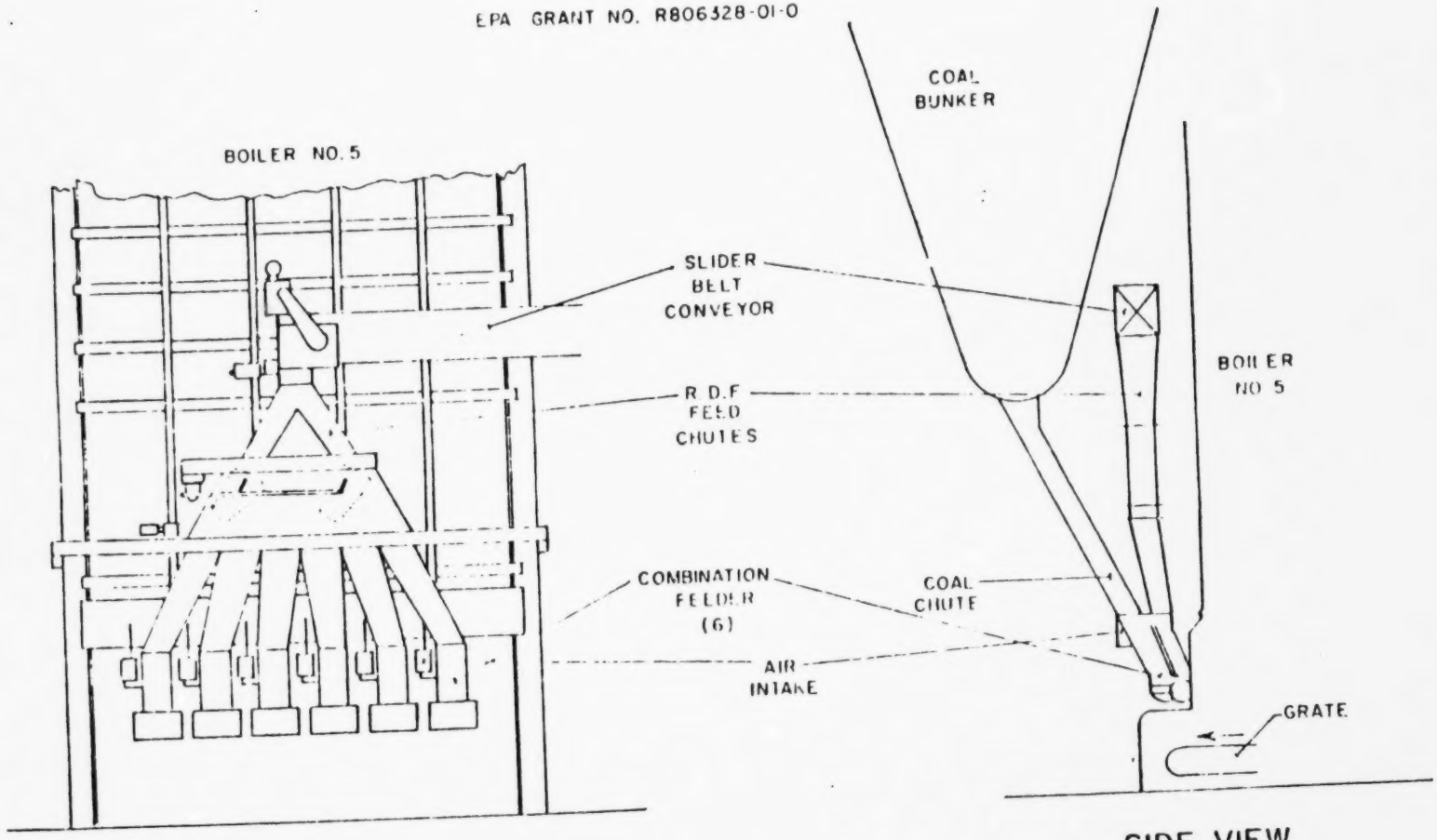
PLAN VIEW

DIVISION OF ENGINEERING - CITY OF MADISON, WISCONSIN
DRAWN BY T.L.J. 1-30-80

Figure 4-2

OSCAR MAYER BOILER FEED SYSTEM

EPA GRANT NO. R806328-01-0



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DRAWN BY TLJ 1-30-80

CHAPTER 5

THE CALIFORNIA PERSPECTIVE

INTRODUCTION

In this chapter, the Madison Energy Recovery Project is examined with respect to its viability as an RDF production and combustion project in California. Particular attention is directed at the issues of ash disposal and air pollution, and to the permitting process.

PROJECT LOCATION

The demographic characteristics of the Madison area may be approximated in California, but corresponding geographic conditions do not occur. Madison is situated amidst a chain of four small lakes in an area of plains farmlands. The general conditions of a medium-sized city (approximately 170,000 population) situated in farmlands can be found in several San Joaquin Valley cities, however, the mountain ranges bounding the San Joaquin Valley to the west and east create climatic and meteorological conditions much different from those of the Midwest. The generally poor air quality conditions existant in the San Joaquin Valley are to a large extent determined by climate and topography which do not exist in the Madison area.

ASH DISPOSAL

The residue handling and disposal method currently practiced at the Blount Station would not be permitted in California. Fly and bottom ash from refuse combustion, including RDF, are loaded on trailers and taken to one of several private landfills in the area. The California State Department of Health currently requires disposal of this type of ash in Class I or II-1 landfills, which are more expensive than Class II-2 disposal sites (most commercial and municipal refuse sites). If this type of project were to be located in California, availability of properly classified landfill capacity would be an additional planning consideration, as would the potentially higher disposal costs involved.

AIR POLLUTION

The status of the Madison project with respect to air emissions compliance was discussed in Chapter 4, Impact Assessment and Compliance. The June, 1981, stack testing at the Blount Station will have an important impact on the compliance status of the project as it is now operating. In addition, emissions data from the Oscar Mayer RDF test burn program should provide valuable data on RDF combustion emissions under a variety of conditions.

The Department of Natural Resources required review of dust control systems at both the RDF production plant and the RDF receiving facility. Approvals were issued by DNR for baghouses at each installation. No other regulated emissions occur at these facilities.

While siting of an RDF production or handling facility would probably not present major air quality control problems, combustion of RDF in California presents a complex situation. Combustion of RDF and coal would present an extremely difficult permitting situation in many, if not most, areas of California. Depending on siting and the status of regulated pollutants in the area, a facility may be required to use advanced pollution control technology and to make a "good faith effort" to obtain emission offsets. Two reference documents on this subject are the "Air Pollution Aspects of Resource Recovery," California Air Resources Board, March 1980, and the "Report to the Legislature - Refuse to Energy Conversion Projects," California State Solid Waste Management Board, July 1980.

WASTEWATER

No significant wastewater discharges are associated with any phase of the Madison Energy Recovery Project; ash at the Blount Station is not water quenched and boiler blowdown is sewered without pretreatment. A similar facility in California, with ash quench overflow or boiler blowdown discharged into a sewer, would need to obtain approval of the local sanitation district. Approval of such a discharge would be based on that district's ability to handle the quantity and content of the wastewater. Pretreatment at the site could be required prior to discharge.

STATE SOLID WASTE MANAGEMENT AGENCY

The Wisconsin Department of Natural Resources, Division of Environmental Standards, is responsible for all solid waste matters through its Bureau of Air and Solid Waste Management. The Bureau has two sections - solid waste and air quality. All permitting and approvals were administered through this Bureau. During the long evolution of the Madison project, the Bureau was reorganized, and, like many government agencies, it is subject to frequent personnel changes. To the Madison project's advantage, the same Bureau engineer, Mr. Pete Kmet, was involved in the solid waste aspects of the project from preliminary planning to final approval. This was an important factor in the ease and expediency of permitting the Madison project.

Central to the further development of resource recovery projects in Wisconsin is the Wisconsin Solid Waste Recycling Authority (WRA). While playing no role in the development of the Madison project, the WRA has prime responsibility for development of resource recovery projects in the state. This agency was created by the state legislature in 1975 and formally organized in 1977, subsequent to the resolution of legal issues. The Authority was originally given a mandate to develop resource recovery in three distinct districts within the state. Development outside these three districts is authorized only if a county petitions the Authority to intercede or if the Authority determines a specific area has well-defined potential for resource recovery.

The WRA is authorized to plan, develop and implement resource recovery projects. The Authority can control waste delivery within a specific region as authorized by the legislature. Upon authorization by the state legislature of a specific bonding limit for a region, the WRA can finance resource recovery projects through revenue bond issues with security provided by the state. The Authority can only contract for the operation of resource recovery projects; it is prohibited from operating them itself. In the development of its projects, the WRA can delegate some project responsibilities to other agencies, i.e., county or city agencies.

The role of the California State Solid Waste Management Board (SSWMB) in a Madison-type project would have been considerably different from that which was actually played by the Wisconsin Department of Natural Resources or that which might have been played by the Wisconsin Solid Waste Recycling Authority. The SSWMB is authorized to provide funds for the various study phases of project development. Additionally, some money might be made available for specific equipment purchase, if so authorized by the State Legislature. Such funds could be grants or loans. In this way, the SSWMB can provide important support of the developing project at critical stages. The Board would also make available, as possible, technical assistance.

The SSWMB is also, however, a regulatory agency and as such would be directly involve in the project's permitting process. The Board permits all solid waste handling or processing facilities. As part of this permit the proposed facility must be in confor-

mance with the local (County) solid waste management plan. The SSWMB must find the facility in conformance prior to issuing a facilities permit. Thus, the SSWMB serves as both a regulatory agency and a resource/supporting agency. No comparable dual function is assigned to any one Wisconsin agency. This dual role would ensure the Board's knowledge of and participation in any project similar to the City of Madison's.

PERMIT PROCESS

Some details of the project's permit process were discussed in Chapter 1. The permitting of the Madison Energy Recovery Project was much less complex than it would be for a similar project in California. The process was greatly simplified by the project's use of existing structures, which allowed simply modifying permits. The original Olin Avenue shredding plant permit was modified, as were existing permits for particulate emissions at Blount Station and Olin Avenue. Only two new permits were required for the entire project - approval of the Olin Avenue permit modification and a new permit for the RDF receiving facility as a solid waste processing and handling facility. It was also necessary to obtain two approvals from the DNR's Bureau of Air Quality for the air emissions (dust) both at the RDF production plant and at the receiving facility. However, no formal permits were issued for dust emissions.

The permitting of a similar facility in California would be a complex process. The requirements of the California Environmental Quality Act (CEQA) would, in all probability, necessitate preparation of detailed environmental impact documents. Permits would be required at the local, regional, state and possibly federal levels. This process could be costly, time consuming, and an impediment to development. Such obstacles did not occur in Madison.

FINANCING

The State of Wisconsin supports no programs to assist in the financing of Madison-type projects, i.e., developed by a municipality or county. The City of Madison was able to finance the entire project through internal budget allocations, utilization of revenue sharing funds (CDBG monies), and the issuance of general obligation bonds. A similar financing approach would not be possible in California due to the restrictions imposed by Proposition 13, which prohibits municipalities from issuing general obligation bonds.

A municipality in California seeking to finance a Madison-type project could issue industrial development bonds, which are long-term, tax-exempt obligations issued by a public agency on behalf of a private enterprise. Such bonds are secured by payments made to the issuer by the private corporation, and therefore, the interest rates thereon are dependent upon the creditworthiness of the corporation itself. In California, cities and counties have the right under the California Industrial Development Financing Act to establish an industrial development authority and to issue revenue bonds to finance privately-owned projects. The law, however, restricts the issuance of industrial development bonds in amount to no more than $10 million. All of the usual industrial bond provisions are included in the Act. The $10 million available through this source is generally not sufficient to fund a major project unless there is a very large contribution from another source such as private equity.

In California, the only entity empowered to issue such industrial development bonds in greater amounts than $10 million is the California Pollution Control Financing Authority (CPCFA). The CPCFA was created by the Legislature in 1973 and is governed by the California Pollution Control Financing Authority Act. As resource recovery projects are regarded as pollution control facilities under Internal Revenue Service

regulations, they are eligible for revenue bond financing under the Authority's program. Resource recovery facilities must convert wastes to a useful form of materials or energy only as a means of waste disposal. Such projects must be certified by the Solid Waste Management Board for conformance to county plans, for need, for furtherance of environmental objectives, and for having solid waste disposal as the primary project function.

The relatively low capital requirements of the Madison project simplified the structure of project financing. The probable higher cost of development in California and the lack of general obligation bonds might require a much more complex financing of project costs.

CHAPTER 6

PROJECT EVALUATION

PROJECT BENEFITS

The development of the Madison Energy Recovery Project has expedited the City's withdrawal from landfill operations. General sentiment in the City of Madison is very supportive of recycling efforts, and the Madison project has received much public support and approval. No complaints regarding the operation have been registered with the City, MGE, or the Department of Natural Resources. The RDF production plant and receiving facility evidence excellent housekeeping and are exceptionally clean for refuse processing facilities.

The City of Madison has been able to resolve a serious waste disposal problem and to develop a second-generation refuse processing facility, notable for its smooth implementation and successful operation. The facility has experienced no equipment failure, production of RDF is per specification, production rates are consistent, contractual arrangements have proven acceptable, personnel morale is good, and the project, as a whole, continues to enjoy a high degree of public support and approval. The research program developed in conjunction with Oscar Mayer and Company and the University of Wisconsin-Madison should provide valuable data on the combustion of RDF with coal in industrial boilers and on emissions characteristics, thus furthering Madison's position as a leader in refuse processing and RDF production/combustion.

PROJECT-RELATED PROBLEMS

The Madison Energy Recovery Project has been singularly free of major problems. The most serious problem to date has been the formation of clinkers in the MGE boilers, which may limit the amount of RDF that MGE will want to fire.

The Department of Natural Resources' proposed testing for SO_2, chlorides and particulate emissions at Blount Station could result in additional pollution control requirements. To date, the emissions attributable to RDF firing are not known. The test program is tentatively scheduled for June, 1981.

HINDSIGHT EVALUATION

Comments by principal participants in the Madison project indicate a number of things that might be done differently were the project being designed today. These include evaluation of dedicated boilers, redesign of the RDF receiving station and feed system to eliminate spillage and feed rate control problems, and re-evaluation of the selection procedure for the ferrous removal system and combustibles separation unit, in order to enable the City to own all of the equipment within the RDF production plant. This would eliminate the need for current equipment lease arrangements. Some slight modifications in equipment placement and connection (shields, etc.) might be made to facilitate cleaning and maintenance. Project participants generally expressed satisfaction regarding plant design, project implementation, and current operation.

APPENDIX A

FIELD INSPECTION NOTES

GENERAL QUESTIONS

Background: What was the problem that provided impetus?

The City's lack of long-term landfill capacity and inability to site new landfills. An agreement with City residents would close the Green Tree landfill in 1980, the City's last remaining disposal site.

Benefits of the project?

Reduction of refuse requring disposal; production of RDF and energy from refuse; reduced landfill demand; recovery of ferrous metals from refuse.

Does it solve the problem at hand?

Yes, landfill demand has been significantly reduced, the Dane County Verona landfill is able to accomodate the unprocessible waste, refuse processing residues and excess RDF.

Does it cause any other problems?

An increase in per ton disposal costs for the City: approximately $20 per ton of refuse processed versus $7.50 per ton transferred and hauled to Dane County's Verona landfill.

If the same project were begun today, what would differ?

The City would procure the ferrous removal system and the combustibles separation unit as part of general procurement; no lease arrangements would be made. Use of a dedicated boiler for RDF combustion would be examined. The RDF receiving facility would be redesigned to eliminate feeding problems.

Role of State Solid Waste Agency?

Wisconsin Department of Natural Resources, Division of Environmental Standards, Bureau of Air and Solid Waste Management - permitted both RDF production plant and receiving facility as solid waste processing/handling facilities and approved emissions controls (baghouses) for dust at those facilities.

Local governments - how cooperative?

Two communities, Maple Bluff and Monona, currently dispose of wastes at the City's RDF production plant. Other communities are expected to utilize the facility as landfill capacity decreases, particularly after the closure of the Dane County Verona landfill in 1984.

Waste Supply - how obtained?

All waste collected by the City's Sanitation Division (residential and limited light commercial) is deposited at the RDF production plant. No private haulers or private citizens are allowed to use the facility. The refuse of Maple Bluff and Monona is secured by contract with the City of Madison, delivered by those cities' collection services.

Unexploited opportunities for energy/material recovery?

Securing of an additional market or markets would provide enough demand for all RDF that can currently be produced. Approximately 80-85% of current RDF production is consumed by MGE. Oscar Mayer & Co. may be that market, if test results are positive and economics are favorable. The facility could accept more waste and produce significantly higher RDF quantities but no market currently exists; acceptance of additional waste is dependent on securing additional RDF customers.

Critical factors in development of the plant.

The Madison RDF project encountered no significant obstacles to development. The project was supported by the citizens of Madison, by MGE and by the Director of Public Works. Local press coverage was favorable.

PLANNING - STUDIES

1) Phase

Phase	Title	By	Cost	Fund Source
Planning	"Appraisal of Solid Waste as a Supplementary Fuel in Power Plant Boilers"	Horner & Shifrin, Inc. St. Louis, MO	---	City of Madison and MGE
Planning	Report to Board of Public Works - "City of Madison Solid Waste Disposal Alternatives vs. MGE - Energy Recovery"	Dept. of Public Works, Div. of Engineering	---	In-house

2) Alternatives Investigated

Continued Landfill
RDF/Supp. Fuel

3) Wastes Considered

Type	TPY	Avg. TPD	Min/Max (Seasonal Change)
Municipal solid waste (residential) & limited light commercial	55,000	250	140 TPD fall/winter 400 TPD spring/summer

4) Technology Recommended: Shredding; magnetic separation; rotary screening; secondary shredding

Reason: City's experience in shredding refuse; identified customer for RDF, available technology; low capital cost

5) Future Considerations: The City hopes to maximize production capacity at the plant by securing an additional market or markets for RDF. No specific marketing plan has been formulated. Waste disposal through the project is expected to increase as the Dane County Verona landfill reaches capacity, depending on securing of additional RDF customers.

PLANNING - GENERAL

1) Risk Allocation

Type of Risk	Entity Assuming Risk
Waste Supply	City of Madison
Energy Markets	"
Disposal of Residuals	"
Facility Construction	"
Facility Operation	"
Debt Service	"

2) Impetus

Disposal Problem - lack of landfill capacity or new sites

3) Citizen Participation

Committee (formed or existing) - none

Local government involved - N/A

Public Meetings: No., Sponsor, Purpose - Two public meetings were held by the City of Madison as part of the project approval process.

Citizen Complaints - None have been registered with either the City, MGE or the State Department of Natural Resources.

4) Recycling Programs - Prior, Existing and Planned

Type	Material	Tonnage	Market	Price (Date)	Contract
Curbside pick-up	newsprint	23,000 TPY Paper	Pioneer (11/80)	$56/ton	yes
Mechanical Separation from MSW waste stream	ferrous	14,000 TPY	Milwaukee scrapdealer	N/A	N/A
Depository	waste oil	N/A	State of Wisconsin	N/A	N/A

5) Anticipated Efect of Recycling Program on Energy or Material Recovery

No significant impact, if any, is currently made on the composition of incoming refuse. No expansion of recycling efforts is anticipated; no detrimental effects are expected.

6) Site Selection

Procedure - Utilization of old refuse milling plant; site properly zoned and in use for refuse processing - remodeling of existing structure required.

Public Involvement - Opportunity for public participation existed through public hearings held by the City of Madison; no other public involvement recorded.

Barriers - No barriers existed to the development of the site. There existed, in fact, considerable public support.

OPERATION

1) Feedstock

Composition - Approximate

Paper	35-55%
Yard waste	0-15%
Food waste	5-20%
Wood, Plastic, Rags	1-5%
Glass	5-10%
Ash, Rock, Dirt	1-5%
Ferrous	5-8%
Aluminum & Other Nonferrous	0.7-1.5%

2) Throughput

	Avg.	Max.
Design	50 TPH	65 TPH
Actual	36 TPH	---

3) Energy Output (note variability) 70% Availability

RDF: 19 TPH, @ 6,200 BTU/lb (avg.)

4) Materials Outputs

	Flow Rate (TPH)	
Ferrous	Design	Actual
Ferrous metals	2.5 TPH(avg)	2-3 TPH (avg.)

5) Residuals (indicate point of removal from process flow)

Type	Flow Rate	Disposal Cost	Distance to Disposal Point
Trommel unders	(proprietary)	$3.75 (tipping fee only)	10.5 miles (to Dane County Verona landfill)
Air classified heavies	2.5-3.5 TPH	"	"

6) Process Flow (corrected diagram)

Refer to Figure 2-3

7) Modifications

	Description	Cost	Reason
Completed In Progress Planned	Refer to Chapter 4, Modifications		

8) Maintenance

Requirement	Interval	Cost
	Not Available	

9) Traffic

	Mon-Fri			Sat & Sun		
	Avg.	Min.	Max.	Avg.	Min.	Max.
General Pub.	not allowed			no collection		
Collection:						
Madison	40-45 loads/day 5 days/week			"		
Monona	3 loads/day 4 days/week			"		
Maple Bluff	2 loads/day 3 days/week			"		

FINANCE

1) Project Initial Costs

	RDF Production Plant	RDF Receiving Facility
Consulting	$ 38,190	$ 15,000
Architecture & Engineering	258,467[a]	103,135[d]
Land	72,028[b]	0
Equipment	1,083,770	537,377[e]
Construction	1,113,324	306,236
Startup	168,802	100,000
Administration	108,555[c]	—
Other	—	—
	$2,843,136	$1,061,748

2) Annual Operating Costs

	1979		
	1/79-6/79 Shakedown	7/79-12/79 Normal Ops	1980
Personnel	$ 83,577	$ 100,094	$ 203,794
Power & Fuel	28,372	55,495	153,423
Maintenance Material	56,896	85,740	155,491
Maintenance Labor	20,772	28,701	84,142
General & Administration	2,685	3,815	1,407
Taxes	—	—	—
Disposal Fees	f	f	39,348
Other - MSWF Co.	—	78,890	161,799
Amortization - City Capital	—	171,028	353,574
Miscellaneous	—	—	18,735
	$192,302	$523,763	$1,171,713

3) Annual Revenues

			Monona/ Bluff
Drop Charge - Maple Bluff	0	$ 1,670	21,722
Energy Product(s)	0		151,190
Material Product(s)	0		0
Other	—	—	—
MMO & MSWF reimbursement	—	3,949	11,181
	0	$5,619	$184,093

a $103,386, Warzyn Engineering; $155,081, City Engineering
b site improvement
c plant personnel
d $63,135 Warzyn Engineering; $40,000, City Engineering
e $465,516 equipment; $71,861 equipment installation
f interagency charge

4) Financing

Amount	Type*	Term (Dates)	Conditions
A) $850,000	GO	10 yr (1977)	4.06720%
B) $250,000	GO	10 yr (1978)	5.18341%
C) $100,000	GO	10 yr (1979)	5.33609%
D) $ 25,000	GO	10 yr (1980)	6.02461%
E) $ 10,000	GO	10 yr (1980)	—

Preparation Entities	Firm(s)	Cost	Time (Dates)
Financing Consultant Bond Counsel Underwriter Prospectus		Not Available	

Cash Flow Projection

Payback Period	10 years per issue; 13 year total payback period
Plant Life	10 years projected
Salvage Value	$304,070 (RDF production and receiving facilities)

5) Funds spent Prior to Releasing Bonds

Item	Date	Origin of Funds
A) $1.505 MM	1977	direct appropriation from City General Fund
B) .253 MM	1977	transferred from City landfill siting account
C) .250 MM	1978	General Fund
D) .375 MM	1978	Community Development Block Grant (federal)

6) Procurement Process

Cost	Not Available
Procuring Entity	City of Madison
Dates (From - To)	Not Available

7) Acquisition Approach

Conventional
Modified with government operation

Reason for choice: City's experience in shredding

* GO, Rev, Lease/Rev, IDB, Lev. Lease, Other

8) Tipping Fee

After Recovery (Current)

A) $3.75/ton - cost to City for disposal at Dane County Verona landfill
B) $7.50/ton - charge to customers to dispose at RDF facility, equals the City's cost to transfer and haul to Verona

9) Method of Charging Disposal Cost to Users

Periodic billing of charges to Maple Bluff and Monona (four-week periods).

10) Waste Supply Agreements

Description	Supplier	Dates
MSW	Village of Maple Bluff	8/30/79
MSW	City of Monona	3/24/80

PERSONNEL

1) Operating Crew (2 shifts per day, 5 days per week)

Classification	Salary & Benefits	No. (All Shifts)
	Refer to Table 2-3	14

2) Maintenance Crew (_ shifts per day, _ days per week)

Classification	Salary & Benefits	No. (All Shifts)
	Operating crew performs all maintenance	

3) Support Personnel (1 shift per day, 5 days per week)

Refer to Table 2-3

4) Training Program

Refer to Table 2-2

5) Safety Record: Refer to Chapter 4, Plant Reliability

6) Union(s) - Closed Shop

National Association of City, County and Government Employees Union, Local #236

7) Average or Typical Term of Employment: Refer to Chapter 2, Staffing

ENVIRONMENTAL CONSIDERATIONS

1) Permits (Local, State, Federal): Refer to Chapter 1.

2) Wastewater: Not a consideration in project operation.

3) Noise Measurements (Interior & Exterior): No tests conducted.

4) Odor: Reasonable levels; no complaints registered.

5) Aesthetics: Typical industrial appearance.

CHRONOLOGY

A complete chronology is presented as Table 1-1

REFERENCE DOCUMENTS

Articles

Barlow, K.M.; Boley, G.L. and Smith, M.L., "Design, Evaluation and Operating Experience of the City of Madison - Madison Gas & Electric Company Energy Recovery Project," 1980.

Barlow, K.M., "Burning Refuse Derived Fuel in a 50 MW Utility Boiler," 1979.

Boley, G.L. and Smith, M.L., "Development and Implementation of a Resource and Energy Recovery Program for the City of Madison, Wisconsin."

Easterbrook, G., "Madison's Shredding Plant Gets Recycled into a Recycler," 1979.

Musselwhite, R.W., "Resource Recovery in Madison," 1980.

Maps

State of Wisconsin
City of Madison

Studies and Reports

Horner & Schifrin, Consulting Engineers, "Appraisal of Solid Waste as Supplementary Fuel in Power Plant Boilers," 1974.

Boley, G.L., "Report to the Board of Public Works: City of Madison Solid Waste Disposal Alternatives versus MGE - Energy Recovery," 1976.

Jagelski, T.L., "City of Madison: Department of Public Works Solid Waste Management Annual Report," 1979.

Jagelski, T.L., "City of Madison: Department of Public Works Solid Waste Management Annual Report," 1980.

Jagelski, T.L., "City of Madison: Department of Public Works Energy Recovery Program Annual Report," 1980.

Dane County Regional Planning Commission, "Preliminary Solid Waste Management Plan," with proposed revisions, 1980.

Dane County Regional Planning Commission, "Solid Waste Management in Dane County," 1980.

Madison Gas & Electric Company, Annual Report, 1979.

Proposals

None

APPENDIX B

BIBLIOGRAPHY

Plans/Specifications

Olin Avenue Refuse Reduction Plant, proposed plant layout.

Specifications - primary shredding system
Specifications - secondary shredding system
Draft specifications - combustibles separation system

EIR/EIS

None

Regulations

State of Wisconsin, Department of Natural Resources. Chapter NR 180, solid waste management.

Permits and Approvals

City of Madison: Olin Avenue refuse reduction plant - Madison. Solid waste plan approval, Department of Natural Resources, 1978.

City of Madison: Madison-MGE RDF facility. Solid waste plan approval, Department of Natural Resources, 1978.

Oscar Mayer & Company: Refuse Derived Fuel (RDF) facility. Solid waste plan approval, Department of Natural Resources, 1979.

City of Madison: Olin Avenue refuse reduction plant, plant modifications, 1977. Department of Natural Resources license no. 2026.

Prospectus

None

Letters of Intent

None

Contracts, Agreements and Supporting Material

City of Madison - Madison Gas & Electric agreement for production and combustion of RDF, 1977.

City of Madison resolution authorizing negotiation for above agreement, 1976.

City of Madison - MGE administrative procedures for above agreement, 1980.

MGE letter of acceptance of RDF product, 1980.

City of Madison - Continental Can Company, Inc., agreement for ferrous metal removal system, 1971.

City of Madison - Madison Solid Waste Fuel, Inc., agreement for combustibles separation system.

City of Madison - Village of Maple Bluff authorization to dispose at Olin Avenue refuse reduction plant.

City of Madison - City of Monona agreement to dispose at Olin Avenue refuse reduction plant.

Grant Applications

City of Madison, Engineering Division; University of Wisconsin - Madison, Department of Mechanical Engineering and Oscar Mayer & Company, Madison. Grant application to EPA: Test Firing RDF in an Industrial Coal-Fired Boiler; 1978, with related documents below.

Ragland, K.W., "Sampling and Analytical Plan for Test Firing RDF in an Industrial Coal-Fired Boiler," 1979.

Boley, G.L., "Test Firing Refuse Derived Fuel in an Industrial Boiler," 1979.

Miscellaneous

Olin Avenue refuse reduction plant salaries.

Olin Avenue refuse reduction plant personnel training program.

City of Madison, Department of Public Works, Olin Avenue refuse reduction plant and MGE RDF facilities: capital budgets, 1977, 1978, 1979.

Energy Recovery Program financing breakdown, 1977, 1978, 1979, 1980.

Energy Recovery Program, capital costs and cost projections, 1980, 1985, 1990.

RDF quality data, August and September, 1980.

ANNOTATED BIBLIOGRAPHY

Barlow, K. M., Boley, G. L. and Smith, M. L. "Design, Evaluation and Operating Experience of the City of Madison - Madison Gas & Electric Company Energy Recovery Project," Proceedings of the 1980 National Waste Processing Conference, ASME, 1980.

This 15-page article presents a concise description of the Energy Recovery Project, its individual components and process specifications. Figures of key processing systems and facilities are presented, as are capital costs and operating costs. The article describes start-up experiences for both the processing plant and MGE RDF combustion and includes an initial evaluation of RDF quality.

Barlow, K. M. "Burning RDF in a 50 MW Utility Boiler", 1979.

This paper, written by the MGE plant manager, details the initial experience of the utility in firing RDF. Boilers, necessary modifications and operating procedures are described, with particular attention to the problems encountered in RDF feeding and combustion. Also provided is RDF firing data, including information on quantities

burned, firing times and feed rates, fuel replacement rates and data on RDF quality compared to coal quality during the same firing period. The paper also addresses unresolved problems such as ash bridging over the drop grates and difficulties in supplying sufficient underfire air for complete combustion of the RDF.

Boley, G. L. "Report to the Board of Public Works: City of Madison Solid Waste Disposal Alternatives Versus MGE-Energy Recovery," February, 1976.

This report compared the City's solid waste disposal alternatives (milling of refuse prior to landfill-existing system, direct haul to County landfill, transfer-haul to County landfill) with two versions of the MGE-energy recovery plan. This report clearly established the comparative costs of these options and the MGE-energy recovery scenarios as the most expensive option. The report served as the basis for the City's decision to proceed with MGE-energy recovery.

Jagelski, T. L. "City of Madison: Department of Public Works Solid Waste Management Annual Report," 1979.

This document provides detailed data on the expenditures and revenues of the Energy Recovery Project during the initial six-month shakedown period and subsequent six months of normal operation.

Jagelski, T. L. "City of Madison: Department of Public Works Energy Recovery Program Annual Report," 1980.

This report details the system performance of each Project component - RDF production, RDF receiving and feeding, combustion - for the first full year of normal operation, including quantities processed, percent downtime, overall availability, etc. The report presents information on revenues and expenditures and a particularly interesting statement on project goals for 1981.

City of Madison resolution authorizing negotiation of agreement with Madison Gas & Electric, March, 1976; City of Madison - Madison Gas & Electric agreement to produce and combust RDF, January, 1977.

The March, 1976 resolution authorized the Department of Public Works to negotiate an agreement with MGE, which was subsequently signed in January of 1977. The agreement specifies basic conditions for the joint program including division of capital costs, payment for RDF (limited to actual quantity burned) and lease and operation/maintenance conditions for the RDF receiving facility. Administrative procedures for billing and payment of fees and service charges were not formalized until 1980; additional administrative procedures are to be developed.

Ragland, K. W. "Sampling and Analytical Plan for Test Firing RDF in an Industrial Coal-Fired Boiler," Department of Mechanical Engineering, University of Wisconsin-Madison, March, 1979.

The paper, presented as supporting information for the City of Madison - Oscar Mayer EPA grant application, details the sampling and analytical procedures that have been utilized in the test program. The paper provides information on the data to be gathered in the test program, including replacement rates for RDF, boiler steam load, ash analyses and emissions data.